Distr.
LIMITED

ID/WG.449/1
19 September 1985

ENGLISH

United Nations Industrial Development Organization

Expert Group Meeting on the Development of
Multi-purpose Agricultural Machinery Plants

Guangzhou, P.R. of China, 13 to 18 November 1984

CONCEPTUAL FRAMEWORK AND ASPECTS OF MULTI-PURPOSE PRODUCTION OF ENGINEERING AND AGRICULTURAL MACHINERY PRODUCTS: SOME PROPOSALS BY UNIDO *

prepared by the

UNIDO secretariat

* This document has been reproduced without formal editing.

V.85-31045

Table of Contents

		Page
I.	BACKGROUND AND JUSTIFICATION	3
II.	THE UNIDO APPROACH TO THE MANUFACTURE OF AGRICULTURAL MACHINERY IN DEVELOPING COUNTRIES	5
III.	A PROPOSAL FOR THE CONCEPTUAL FRAMEWORK OF MULTI-PURPOSE PRODUCTION	9
	Introduction	9
	Criteria for the composition and structure of multi-purpose plants	10
	Considerations on training	13
	Multi-purpose production, external know-how and standardization	15
	Possible sizes of multi-purpose plants	16
	The dynamic character of multi-purpose plants	17
	Agricultural machinery and multi-purpose units	19

I. BACKGROUND AND JUSTIFICATION

1. The Second Consultation on the Agricultural Machinery Industry, held in Vienna (Austria) from 17 to 21 October 1983, proposed and discussed in depth the issue of the integrated manufacture of agricultural machinery and capital goods.[1/] One main conclusion was that "production of agricultural machinery should be considered as an integral part of national industrialization including the promotion of engineering and capital goods manufacturing programmes. It is therefore essential to develop programmes of product diversification and to introduce batch-level manufacturing. Combined production could be established in multi-product production plants with a view to accelerating the development of the engineering and capital goods sector including agricultural machinery."[2/]

2. The Consultation "recognized the validity and applicability of the concept of the multi-product production units for the manufacture of agricultural and capital goods equipment in developing countries. In areas where such units already exist, better capacity utilization is possible by adding new products, even if they are needed in other sectors, that suit the available production facilities. The exchange of information between the local partners, including Governments, should be strengthened."[3/]

3. The Consultation recommended the establishment, under the auspices of UNIDO, of a group of experts composed on the basis of equitable geographical distribution, taking into account the need for interested partners, including Governments, manufacturers and users of agricultural machinery, to be represented:

"(a) To carry out a precise assessment, on a selective basis, of the needs in terms of products and technology in purchasing countries, and of the industrial capacity available in supplying countries in terms of products, components and research and development. Based on this assessment, the expert

---

1/ See issue paper II (ID/WG.400/5), 21 September 1983, background paper to issue paper II (ID/WG.400/6) and UNIDO working paper on the "Integrated manufacture of agricultural machinery and capital goods: Multi-purpose production routes".

2/ See Report (ID/307), para.54, page 17.

3/ Ibid., para.10, page 6.

group should work out particularly the details of the application of the multi-product approach and demonstrate practical ways of implementing this approach by establishing pilot multi-purpose plants, up-grading utilization of existing plants and adapting, as far as possible, techniques and products."4/

4. The meeting in Guangzhou is the first meeting of this group of experts recommended by the Second Consultation. Therefore, it was felt necessary that the concept of multi-purpose production should be discussed and clarified so that the long-term efforts to be developed will be based on a sound and clear philosophy. In fact, experience has shown the risk of distorting the concept in the following ways: it is neither new nor original; multi-product/purpose production exists and often dominates in many countries of the world, including developed countries; this approach is similar to product diversification and management of a product-mix. Experience has also shown that multi-purpose production appears in different forms: from the small rural workshop to the fully automatized flexible manufacturing workshop equipped with robots. The concept may also raise opposition, both of a theoretical nature, since it contradicts the law of economies of scale of specialized mass production, and of a practical nature, because of the difficulties of management and organization of production.

5. For these reasons, UNIDO considered it useful to include in the work programme of this meeting a discussion on the conceptual basis and rationale of the multi-purpose approach. This discussion should, however, be realistic: on the one hand, there is a need to find and define a "common line" among the various experiences so as to provide the multi-purpose approach with a certain identity and philosophy. On the other hand, it is necessary to relate theoretical hypotheses and/or concepts to practical experiences. Therefore, an "experimental research" approach should be followed during this Meeting, where concepts and experience are considered at the same time and are mutually supportive.

4/ See Report (ID/307), para.12 (a), page 6.

6. To t kle the conceptual aspects, UNIDO undertook research work, applying the methodology of Analysis of Technological Complexity (ATC), developed by UNIDO since 1979 in the field of capital goods, to the specific question of multi-purpose production.[5/] Because of the short time available and the various tasks to be performed during the Meeting, and also because of the very particular methodological content of ATC, it is not possible to discuss this work extensively during the Meeting. However, this paper intends to introduce some important aspects of ATC, in particular those related to the criteria of composition of multi-purpose plants (part III).

7. Before dealing with the technical rationale of multi-purpose plants, it seems useful to try to answer the basic question of "why multi-purpose production of agricultural machinery?". The multi-purpose production concept should correspond to a certain vision of manufacturing that ought to be reasserted.

II. THE UNIDO APPROACH TO THE MANUFACTURE OF AGRICULTURAL MACHINERY IN DEVELOPING COUNTRIES

8. Promoting the multi-purpose approach in the field of agricultural machinery has two basic aims/objectives:

- meeting the needs of farmers and rural development;
- forming a nucleus for the starting/strengthening of the industrialization process in developing countries.

9. As is clearly reflected in the first UNIDO World-Wide Study on Agricultural Machinery[6/] which was presented at the First Consultation on the Agricultural Machinery Industry, held in Stresa (Italy) in October 1979, UNIDO attempts to promote the idea and determine the characteristics of

---

5/ Title of the study: "Essay on the multi-purpose production units. Theoretical considerations and practical applications." This work was carried out by Mr. Franco Vidossich (Brazil), author of the methodology, in co-operation with UNIDO, and currently project co-ordinator of a UNIDO project in Tunisia, using the ATC methodology for the development of the national engineering industries.

6/ UNIDO/ICIS.119.

alternative patterns of production of agricultural machinery, better adapted to the priority needs and conditions of developing countries. The following facts justify this effort for finding alternatives:

- Developing countries produce about 10 per cent of the world production of agricultural machinery, while representing more than 80 per cent of the world farming population;

- There are enormous needs for equipment for the agricultural and rural sectors in developing countries. These needs can be met only partially by the imports from developed countries[7] because the equipment ought to suit the variety and specificity of agricultural, climatic and social conditions. For example, 80 per cent of the farmers in the world cultivate an area of less than one hectare. It is therefore impossible for them to buy and rationally use conventional tractors. The food challenge in most developing countries calls for a drastic increase in the local capacities for designing, producing, maintaining and repairing the most important agricultural and rural equipment.

10. When manufacturing capacities exist, it is observed that in many countries they operate at a very low utilization rate and face many difficulties.[8] Although the prevailing agricultural crisis and the low price level of agricultural commodities definitively affect the purchasing power of farmers and decrease the market for agricultural machinery, this situation also witnesses the failure of specialized large plants designed for the mass production of one product. In fact, in many countries, especially those of a small or medium size, the needs of the farmers are wide in terms of variety, but small in terms of quantity. Multi-purpose agricultural machinery plants are desirable in order to meet the diversified requirements of farmers and related rural activities (storage, transport, etc.). The golden rule to be followed was expressed by Mr. Wang Wanjun, referring to the Chinese experience: "If the agricultural machinery plants want to get a foothold in the country and become flourishing, they must do whatever the farmers need."[9]

7/ These imports are drastically cut down because of the enormous foreign exchange problems that many developing countries are facing.

8/ See the study on Africa "Agricultural Machinery and Rural Equipment in Africa; a New Approach for a Growing Crisis" (UNIDO/IS.377).

9/ Wang Wanjun, "Establishment of a Multipurpose Agricultural Machinery Plant", paper prepared for UNIDO, 1984.

11. This approach is in line with two main principles developed by UNIDO in its previous work:

- The agricultural machinery sector is at the interface between agriculture and industry. Its success and development depend fundamentally on its ability to meet agricultural requirements. In this sector, industry should be at the service of agriculture. However, without a good national agricultural machinery sector, agricultural mechanization and food development are doomed to failure, because it will be impossible to increase sufficiently the productivity of land and rural manpower.

- Agricultural machinery should be considered in its wider sense and therefore include the various metal products and engineering equipment needed by all priority agricultural and rural activities (including irrigation, storage, food processing, construction, transportation).

12. The principle of meeting the diversified needs of farmers and related rural activities is full of significance and consequences. It expresses a "living" linkage between the plant/unit and the farming and rural world, in the following ways:

- multi-product production (because of the various needs), or multi-function, in particular the necessity/interest of having repair activities, manufacture of spare parts, sales and maintenance of equipment in use in the region in the same unit;

- necessary knowledge and "follow-up" of the needs, to be translated in appropriate designs, prototypes and models of products, and involving a certain "feeling" and capability of the entrepreneur to adapt and satisfy the market requirements;

- importance given to the after-sales service, training of the users for the operation and maintenance of the equipment;

- adaptation to the variable character of this demand (seasonal variation of the needs, dependence on contingent factors like climate, purchasing power of farmers, role of co-operation and parastatal organizations in the choice and supply of agricultural machinery);

- full integration (physical, human) in the rural milieu in terms of resources (local manpower), and constraints (transport infrastructure, supply of raw materials, energy, industrial supportive activities, training, banking, etc.).

13. Another function to be fulfilled by a multi-purpose unit is its role in the introduction or strengthening of a more self-reliant and indigenous industrial development. In fact, countries which are less industrialized and have low national incomes are those where the need for a vigorous development of national manufacture of agricultural machinery is of crucial importance in order to meet the requirements of farm mechanization, food production and rural development. This shows that the agricultural machinery sector has a key function to play as a nucleus and catalyst of industrialization in an unfavourable environment. How can this objective be achieved?

14. Firstly, as recommended by the Second Consultation, the integrated manufacture of agricultural machinery and capital goods (engineering products) should be considered. Secondly, it has been observed that specialized units can rarely fulfil such basic functions in the process of industrialization in countries at early stages of this process. Sometimes such units are a "caricature" of industry, performing only final assembly without enabling the increase of local/national industrial integration, the accumulation of technical knowledge, and without attaining a minimum of profitability.

15. Multi-purpose agricultural machinery plants (MPAMPs), while meeting the various priority needs for engineering products of agricultural and rural sectors, should contribute to the process of industrialization through the use of local resources and manpower, the acquisition and mastery of efficient and adapted technology.

16. The multi-purpose approach corresponds to the search for a possible new combination of technological potentialities and resources (primarily from the country itself), which are mainly manpower and equipment, into efficient systems of production/manufacturing units, capable of meeting the two fundamental objectives stated above. Because of the variety of countries, situations, needs and objectives, it is clear that there is no standard multi-purpose agricultural machinery plant. There are and there will be different types of multi-purpose agricultural machinery plants, characterized by various sizes, levels and types of technology, social nature, etc.; this will be evidenced by the experiences and papers to be presented at this Meeting. However, all multi-purpose agricultural machinery plants have or should have a common technical rationale that ought to be clearly identified.

III. A PROPOSAL FOR THE CONCEPTUAL FRAMEWORK OF MULTI-PURPOSE PRODUCTION[10/]

Introduction

17. As already mentioned, the existence of too many techno-economic limitations obstructing the creation of engineering industries or preventing their development in many developing countries justifies the search for alternatives. A structural formula capable of dynamizing the activity of engineering industries of developing countries could be that of multi-purpose production units. They should replace the large production runs of specialized companies (which are almost always incompatible with the markets of developing countries) by production in smaller batches of a certain variety of specific products. All the same, these units must operate with "critical masses" of sufficient size to ensure that a minimum of industrial significance (economic and technological) is retained in this structural change.

18. The production of finished and intermediate engineering goods and components in the engineering industries of developing countries will therefore be achieved either by imitating specialized production units in the industrialized countries, accompanied by the greatest possible reduction in size, or by multi-purpose enterprises that have replaced series production by the manufacture of a range of types, models and special products.

19. This approach is attractive, particularly as it seems to be difficult to envisage other valid structural alternatives. However, if multi-purpose units are to maximize their advantages for the developing countries and minimize their limitations and weak points, they must be designed and operated according to precise rules and in such a way as to keep control over their fields of action.

10/ This part is based on the research carried out on the basis of the methodology of Analysis of Technological Complexity, entitled "Essay on the Multi-Purpose Production Units", by F. Vidossich.

20. It will be readily recognized that the degree of flexibility of production incontestably increases as soon as one passes from a combination of series production and specialization towards multi-purpose units. A first objective for the developing countries would therefore already be achieved by making possible production activities that would otherwise be postponed indefinitely. However, in order to achieve another goal which the developing countries can by no means abandon, the multi-purpose units must be designed and operated in such a way that they can accumulate technological knowledge.

21. To guarantee this accumulation process, an endeavour should be made to establish industrial configurations capable of precisely defining the fields of action of the various types of multi-purpose units.

Criteria for the composition and structure of multi-purpose plants

22. With the aim of establishing practical and operational literature in the form of a guide for the developing countries for the design of multi-purpose units and on how they would operate, UNIDO proposes to consider the following series of patterns of multi-purpose units (MPUs).

23. When one analyses the production pattern of OECD countries, for example, one can see that some forms of multi-purpose production already exist. It should be ascertained whether they are applicable to the developing countries and if others can be envisaged.

24. It would be wrong to associate multi-purpose production with random production on the basic assumption that it is sufficient to have a certain stock of machine tools so varied that they can do almost anything. This interpretation is not adopted by UNIDO. It is, rather, desirable to observe and interpret what has already been done in certain developing countries during the last 30 to 40 years in order to decide on criteria for the composition of multi-purpose plants.

25. In order to be acceptable, the composition criteria of multi-purpose plants should be suitable for the production of agricultural machinery (including rural equipment) and capital goods in general. The point of departure is always versatility in small batches and an acceptable operational "critical mass" rather than a high degree of specialization or large production runs. All this should be carried out in such a way that the various products manufactured have some common dominant characteristics (homogeneous characteristics), which should not only refer to the nature of the production equipment.

26. Eleven types of multi-purpose units have been identified, belonging to three characteristic and well differentiated groups:

(a) MPUs whose common dominant and homogeneous element is the production equipment. Four different situations can be noted.

(b) MPUs that are homogeneous in terms of the ranking of well-defined factors. Three main cases can be identified.

(c) A variety of characteristic cases reflecting or belonging to four very different situations.

27. The "common" characteristics of multi-purpose units are as follows:

GROUP I - PRODUCTION EQUIPMENT AND PROCESSES

MPU 1 Metal forming machine tools

MPU 2 Chip removing machine tools

MPU 3 Metal forming and chip removing machine tools

MPP.4 Manufacturing processes

GROUP II - LEVEL OF SOME PRODUCTION FACTORS

MPU 5 Precision and/or quality

MPU 6 Homogeneity of H_d

MPU 7 Homogeneity H_s

GROUP III - MISCELLANEOUS

MPU 8 End-user sector

MPU 9 Common-user sectors

MPU 10 Hi-tech equipment

MPU 11 Repair and maintenance

Some examples for each multi-purpose unit:

MPU 1 Boiler-making without machining (except drilling) - metal structures - vehicle bodywork - simple one-piece components - stamping for third parties

MPU 2 Machines and components in general

MPU 3 Machines and components for engineering industries in general

MPU 4 Electrode position for third parties - various surface protection processes - heat treatment - stress relieving - painting

MPU 5 Measurement and control instruments - standard components for cold stamping and moulds for plastics

MPU 6 Machines, mechanisms, very wide variety of components

MPU 7 Furnaces (medium and high temperatures for a wide variety of uses) - equipment for food processing - equipment for food preservation

MPU 8 Equipment for making bread, rusks, etc. - equipment for service stations - equipment for hospitals

MPU 9 Components for hydraulic, pneumatic, lubrication, vacuum, electric and electronic circuits, optical and other elements

MPU 10 Products manufactured with advanced technology - satellites, telescopes, physical research instruments, rockets

MPU 11 Maintenance of electric motors, pumps, compressors, etc.

28. Figure 1 shows the eleven multi-purpose units selected as well as the most important interactions or linkages between them. That means that there must always be an outstanding dominant characteristic in each multi-purpose unit, but it does not mean that there may not be some degree of coincidence with other multi-purpose units among the remaining ten.

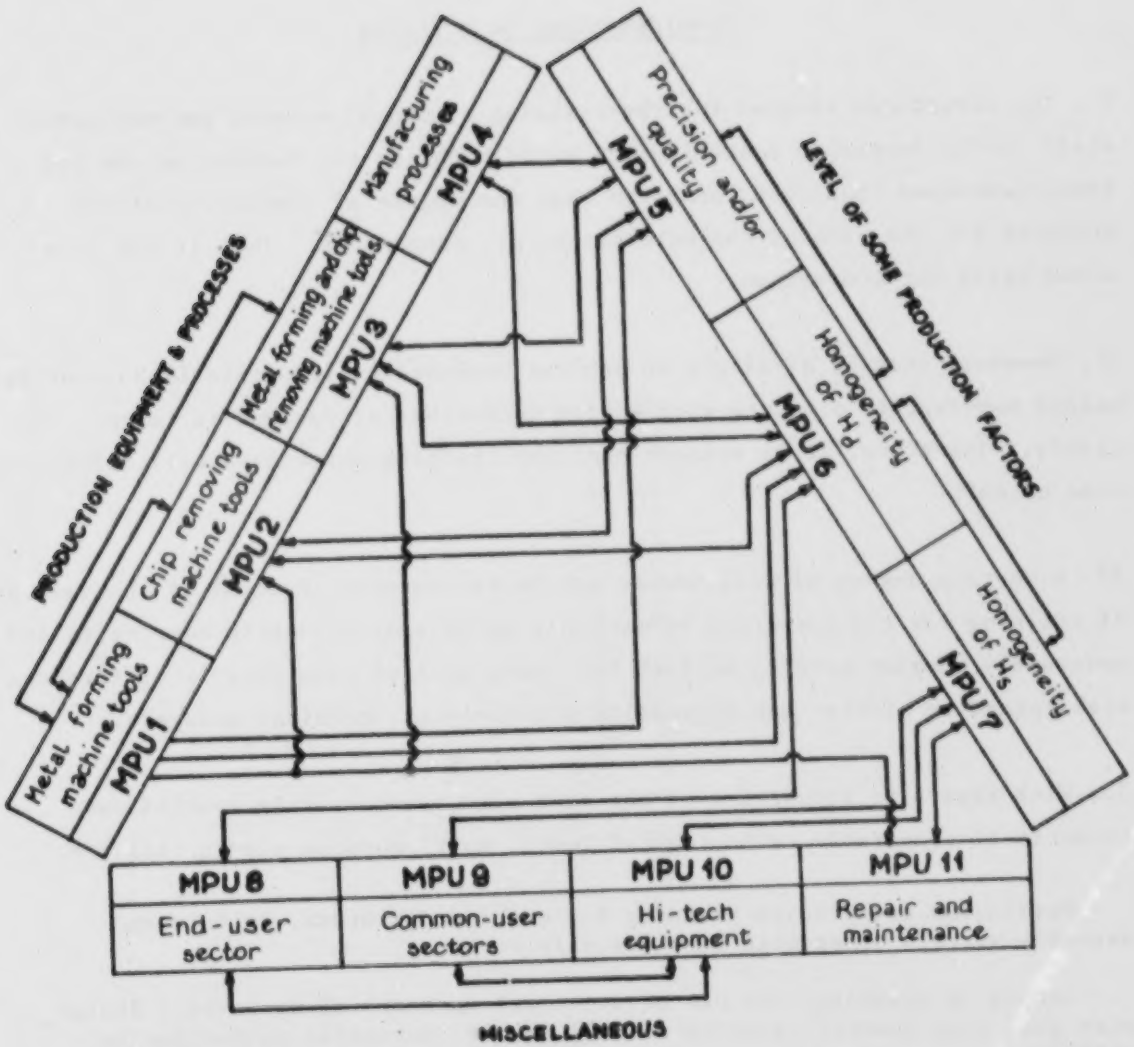


Figure 1: Interactions between the common dominant elements of MPUs

29. If multi-purpose plants are adequate for a lot of developing countries, the question arises whether their large-scale presence in the engineering industries would raise special problems that should be pointed out, particularly in relation to the skills and training requirements.

Considerations on training

30. The structures adopted for the training of manual workers and management staff in the developed countries are valid both for the developing and the least developed countries, provided that the degree of complexity of the products and the size of the enterprises are comparable. That is the only sound basis for comparison.

31. However, that is difficult to achieve because the industrialized countries mainly manufacture products with a high technological content in large plants. Therefore, it is evident that the training structures will differ to some extent.

32. A certain degree of coincidence may be encountered in terms of the variety of training for the operators of machines up to semi-automatic complexity and moderately complex setting skills, but there will be considerable differences with regard to middle- and especially higher-level technical managers.

33. With regard to industries of the same size manufacturing specialized products of comparable technological level, multi-purpose plants call for:

- Meticulous and precise training for machine operators, setters and assembly workers other than line assembly workers;

- Generally speaking, the use of universal machines of up-to-date design with good chip-removal capacity as well as semi-automatic production is sufficient in the vast majority of cases. Specialized machines, numerical control, and other advanced production equipment should always be considered as a secondary option, that is to say an attempt must always be made to redesign products and processes so that conventional machines can be used;

- The technical skills of the setters and fitters must, without doubt, be the highest possible but should always be consistent with the level of technological complexity of the product;

- Middle-level technical supervisors must receive training of the highest quality, always compatible with the technological level of the products. They will have to play a large part in bearing the technical pressure, comprehending and assimilating know-how in multi-purpose enterprises;

- As far as high-level supervisors are concerned, two aspects should be borne in mind. The purchase of know-how and work under licence reduce the scope of action and the contribution of design departments. This has an immediate effect on the corresponding training;

- Ad hoc training must be provided for the management of multi-purpose enterprises, i.e. it must be more intensive and given at an earlier stage than in the case of specialized enterprises of the same size. In fact, multi-purpose plants must operate with a variety of parts machined by third parties and with assembly activities that almost always correspond, in numerical terms, to those of larger specialized firms. In that case, training is required not only for the procurement manager and the production manager but also for the auxiliary technical staff;

- In any case, what was formerly very difficult to manage (it is sufficient to consider the examples of multi-purpose plants in Brazil and Argentina 20 years ago) is now much simpler with the use of micro- or minicomputers, and the difficulties and uncertainties of decision-making have almost disappeared. However, this change in the structure of management, which is incidentally not peculiar to multi-purpose plants, calls for specific training;

- As far as production management within the multi-purpose plants is concerned, it will be noted that it can develop between two structurally very different extremes. On the one hand, the manufacture of many products or articles consisting of only a few parts, and on the other hand, the manufacture of few types of products, each in two, three or five different models and each consisting of many parts.

Multi-purpose production, external know-how and standardization

34. Multi-purpose plants raise a problem with regard to the origin of licences, the purchase of designs and the choice of technical assistance. In order to maximize benefits, it is necessary to reduce the number of technical standards as well as the variety of materials as far as possible, choosing licenses with this in mind.

35. If absolutely necessary, all these licenses can be adapted to a single technical standard, but that takes time and a great deal of technical knowledge, which is often not available.

36. In order for multi-purpose plants to be efficient, it is necessary that there is not too much difference between the degree of technical complexity of the simplest and the most advanced products in the mix. That principle is in line with MPP.6 already described (compatible with the local technical level).

37. Study of an OECD product shows that sometimes its manufacturer needs a special machine or very costly tools. When no alternative exists with other, simpler production equipment, it is advisable systematically to:

- observe what is done with other products with the same function;
- try to redesign certain parts of the product, perhaps with the assistance of the licensor.

38. The same recommendation applies to products that depend on an infrastructure or industrial fabric that is too complex, or on technology that is too advanced (castings, forgings, technical services rendered by third parties).

Possible sizes of multi-purpose plants

39. The multi-purpose approach also raises the following questions: What is the best size, what are the minimum and maximum sizes that can be considered as valid, efficient and manageable in the developing countries and above all in less developed engineering industries? Information gathered from the developing countries clearly shows that the size of the unit must be in direct relation to the complexity of the product. On this point also, it would be important to gather the experience of those present in the Meeting, both in the field of agricultural machinery and other capital goods. The basic criteria for deciding on the size of multi-purpose plants must always be related to correct use of the local/regional industrial fabric, and assembly and semi-assembly activities should be avoided.

The dynamic character of multi-purpose plants

40. Finally, it is necessary to ask the following important question: Can multi-purpose plants guarantee the process of acquisition of technological knowledge or should they rather be regarded as a "passive" form of production, at least in the majority of cases?

41. Initially, multi-purpose plants lead to the accumulation of technical knowledge on production, management and maintenance among users. In-house capacity for product design is considerably diminished by the purchase of a large number of licenses. The purchase of product know-how postpones indefinitely the actual assimilation of know-how. This negative aspect can, to a large extent, be offset by the dynamic role that can be assigned to a wide variety of multi-purpose plants and for products of very widely differing complexity.

42. On the one hand, the multi-purpose plant should be considered as a development pole that in time hands over the manufacture of products or lines of products to new specialized plants. The increase of the markets and the technological mastery achieved, form the basis for this possiblity (see figure 2). On the other hand, it is necessary to offset the "releases" with an inflow of new products or lines of products, while respecting the composition rules indicated in figure 1. This dynamic process of release and inflow must be achieved, and that is possible with a systematic and progressive increase in the technological complexity of the products manufactured.

- Under these conditions and to the extent that they can be consistent with the rules of composition shown in figure 1, the multi-purpose units are transformed into genuine poles of development and as such are irreplaceable in the production context of the engineering industries of developing countries.

- The multi-purpose approach must under no circumstances be considered as a static and isolated solution. We therefore propose that the approach be always associated with a dynamic attitude such as that described above and with a definite pattern of composition (see figure 1).

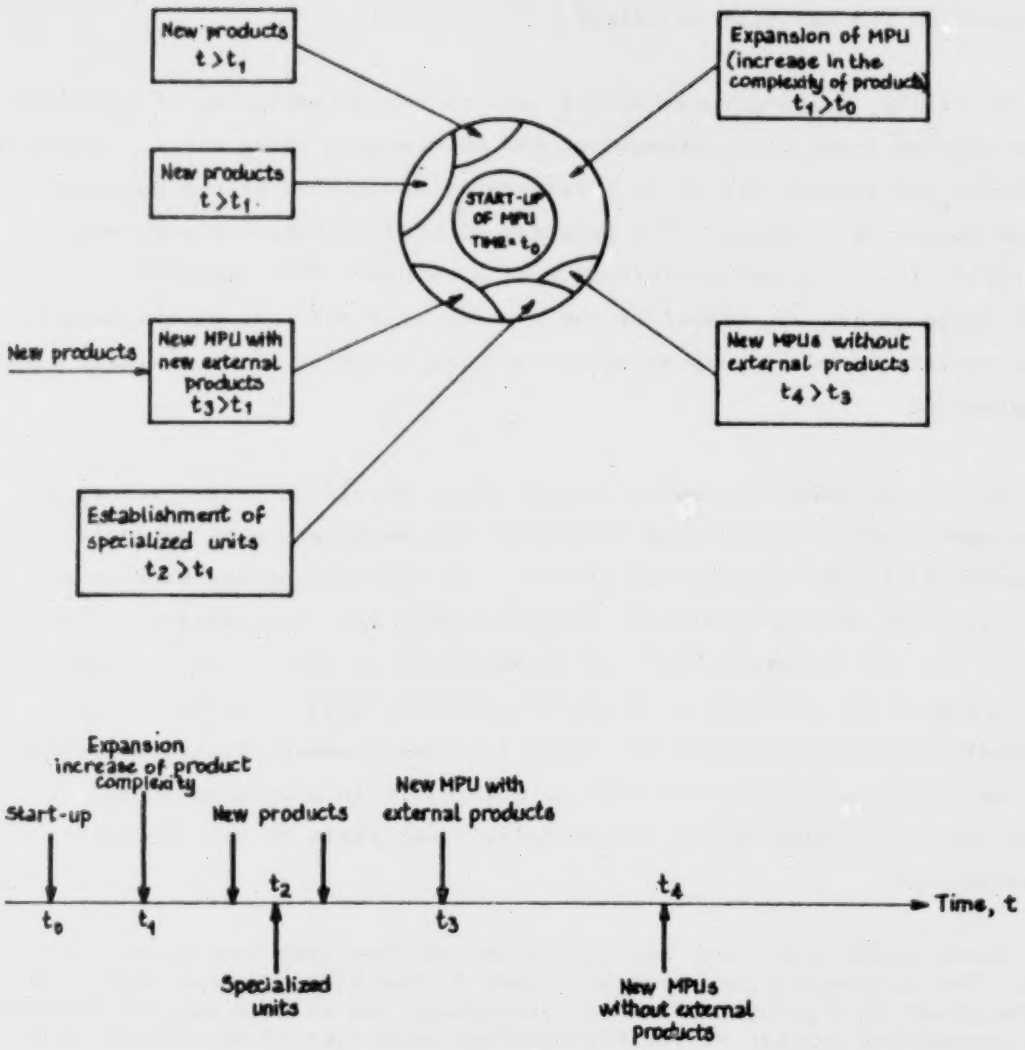


Figure 2: The dynamics of multi-purpose units over time

43. From this point of view, it will then be possible to achieve precise and interesting goals for the developing countries, namely:

- Specific and precise guidelines for the establishment of new multi-purpose activities in existing engineering industries;

- Precise guidelines to rehabilitate and expand the enterprises that are already operational;

- A correct overview in cases when it is necessary to study and promote several multi-purpose plants as part of an industrialization plan (see ongoing UNIDO project in Tunisia);

- A thorough approach when it is desired to make diagnoses of multi-purpose enterprises and to correct any operational defects.

Agricultural machinery and multi-purpose units

44. Agricultural machinery is not a special case but rather represents one of several possible types of final and intermediate capital goods that can be produced by the multi-purpose approach. Therefore, the discussion of the preceeding paragraphs applies here too.

Distr.
LIMITED

ID/WG.449/2
19 September 1985

ENGLISH

United Nations Industrial Development Organization

Expert Group Meeting on the Development of
Multi-purpose Agricultural Machinery Plants

Guangzhou, P.R. of China, 13-18 November 1984

DESIGN AND STUDY OF MULTI-PURPOSE AGRICULTURAL MACHINERY PLANTS*

prepared by

Wang Wanjun**

and

Liu Hong-shu***

* This document has been reproduced without formal editing.
** Chinese Academy of Agricultural Mechanization Sciences (CAAMS), Beijing
*** The 4th Institute of Plant Design and Research, Beijing

V.85-31046

Table of Contents

		Page
I.	Introduction	3
II.	An Approach to the Planning of a Medium-sized Multi-purpose Agricultural Machinery Plant	4
	1. Production Task and Construction Scale	4
	1) Service Range	4
	2) Representative Products	4
	3) Assignment for Repairing Agricultural Machinery	6
	4) Production Program	6
	5) Annual Output Value	6
	6) Some Ancillary Component Parts to be Purchased	6
	2. Plant Planning	6
	1) Production Departments	7
	2) Management Sections	8
	3) Technology Choice and Equipment Disposition	9
	4) Working System	17
	5) Personnel Assignment	17
	6) Factory Building	17
	7) Public Facilities	18
	8) Production Route	18
	9) Plant Layout	20
	10) Main Data for Each Department of the Plant	20
	11) Main Data of the Whole Plant	23
III.	An Approach to the Planning of a Small-sized Multi-purpose Agricultural Machinery Plant	24
	1. Production Task and Construction Scale	24
	1) Service Range	24
	2) Representative Products	24
	3) Assignment for Repairing Agricultural Machinery	26
	4) Production Program	26
	5) Annual Output	26
	6) Some Ancillary Component Parts to be Purchased	26
	2. Plant Planning	26
	1) Production Departments	26
	2) Management Department	27
	3) Technology Choice and Equipment Disposition	28
	4) Working System	32
	5) Personnel Assigned	33
	6) Factory Building	33
	7) Public Facilities	33
	8) Production Route	34
	9) Plant Layout	35
	10) Main Data for Each Department of the Plant	35
	11) Main Data of the Whole Plant	38
IV.	Conclusion	39
V.	Some Issues to be Discussed	40

I. Introduction

China's experience has witnessed that the emergence of multi-purpose agricultural machinery plant at the grass roots level is an inevitable result of the development of agricultural machinery industry. The agricultural machinery plants have been changing in scale and in function along with the growth of industry. However they change, they are commonly characterized by "multi-purpose" function which is of practical significance to China's rural construction. Therefore, it is worthwhile to study into the issue of planning and the establishment of multi-purpose agricultural machinery plant which is considered to be the start point of the agricultural machinery industry.

This paper presents two approaches to the planning of multi-purpose agricultural machinery plants, one of medium-scale and one of small-scale. The authors intend, by introducing and analysing these two approaches to study the proper concept, rational designing, appropriate technology and equipment for projecting a multi-purpose agricultural machinery plant. And also advance some points of importance to the establishment of such plant. Some data are also put forward for reference for those who intend to work out the layout of a specific multi-purpose agricultural machinery plant.

II. An Approach to the Planning of Medium-sized Multi-purpose Agricultural Machinery Plant

1. Production Task and Construction Scale

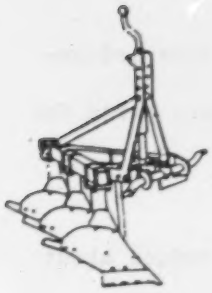
1) Service range: In China, at the grass root, the administrative unit is county which occupies a cultivated area, in the north part of China, about 60,000 hectares. The medium-sized multipurpose agricultural machinery plant should be able to serve the county by producing the main machinery equipment required in agricultural production and some allied production equipment and repair services for rural construction and peasants livelihood as well.

2) Representative Products: The factory should be able to produce fairly complicated machine-powered implements and also to produce various manual or animal-drawn farm implements and tools according to the requirements.

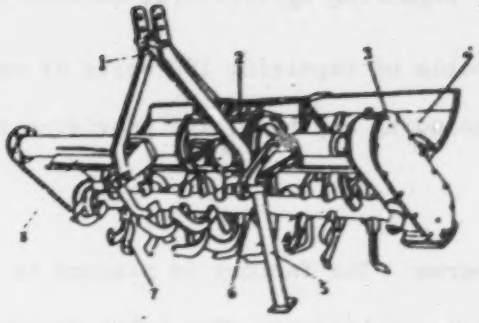
Take the following items as representative products:

1. tractor-drawn, light three-bottom plows
2. tractor-drawn, light harrows
3. tractor-drawn cultivators
4. rotary tillers
5. tractor-drawn grain drills
6. small harvesters
7. small threshers
8. hand sprayers
9. small power sprayers
10. small and medium pumps

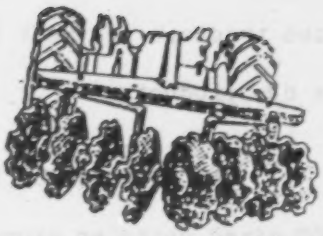
Sketches of the products on the attached sheet



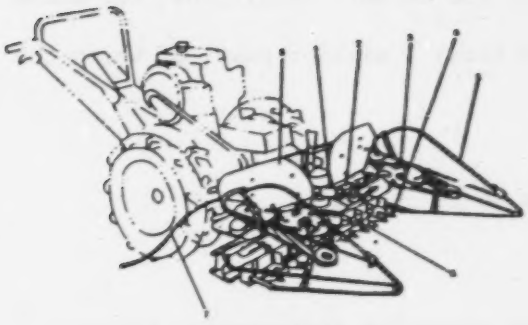
(1)



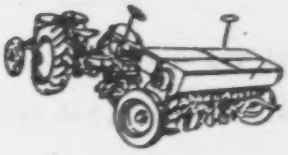
(2)



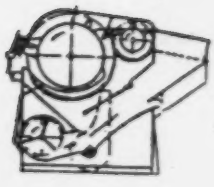
(4)



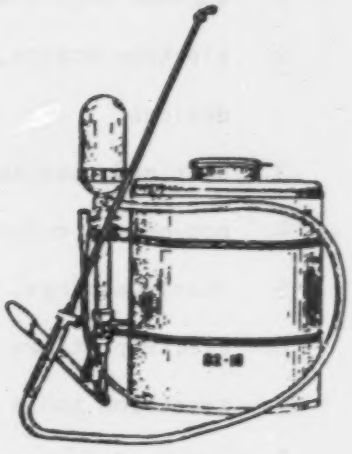
(6)



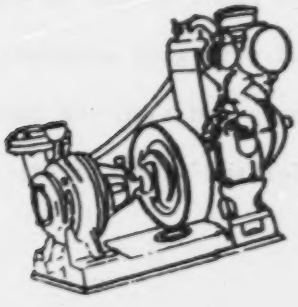
(5)



(7)



(8)



(10)

3) Assignment for Repairing Agricultural Machinery

The factory is capable of repairing 100 units of various medium-sized tractors per year (including engines), and providing spare parts for its own products.

4) Production Program: The factory is planned to produce about 5000 mixed units as above representatives. The total weight of annual output is about 500 tons.

5) Annual Output Value: Under the China's conditions, the annual total value of output in normal case is about 5 million yuan, of which the repair value is 5-6 per cent.

6) Some Ancillary Component Parts to be Purchased

1. engines required
2. electric motors, electronic measuring instruments, control devices
3. bearings, standard parts for fastening, oil seals, chains, etc.
4. non-metal products such as rubber, plastics, leather, glass, etc.
5. steel castings, malleable cast iron, precision castings
6. electroplatings
7. precision tools
8. oxigen for gas cutting etc.

2. Plant Planning

Accoring to above production program, the plant should be equipped with fairly complete types of work in workshops and with good adaptability to making different types of agricultural machinery and also the machines with similar materials and manufacture technologies and with facilities for renewal

of products, for making proto-types and for reforming factory through self-reliance

1) Production Departments

Production is planned to be managed at two levels: plant and workshop. Under the plant, there are seven main production workshops:

1. Foundry shop --- The task is to produce iron castings and non ferrous metal castings used in products and maintenance equipment of this plant. Under the workshop there are groups: melting, moulding, cleaning, non ferrous metal casting and wood-working. The woodworking group can not only make wood pattern but also provide service for product packing and building maintenance.

2. Forging and heat treatment shop --- It consists of two parts: forging and heat treatment. The former is responsible for making forge peice for its own products, tool making and equipment repairing. The latter's task is to do heat treatment for forging pieces and the heat treatment for products, tools, dies and repair-parts.

3. Punching and Welding Shop --- It consists of two parts: punching and welding. The former is to cut, to form from sheet metal and section steel. The later takes the welding work for parts, components and assemblies, and also for non-standard equipment and steel structures.

4. Machine Shop --- It undertakes the machining work for castings, forge piece and other blanks. Some large equipment in this shop can do the machining work for repairing part also.

5. Assembly and Test Shop --- It should be able to perform the following operations for products: parts assembly, total assembly, adjustment test and painting.

6. Farm Machinery Repair Shop --- It ought to be able to repair and adjust tractors (including engines) and various kinds of farm machines, and to make some simple parts and accessories.

7. Tooling and Maintenance Shop --- It is the main auxiliary department of the factory and it should be able to make cutting tools, measuring devices, supplementary holders, jigs, fixtures, patterns, moulds and ordinary production equipment; to make accessories for repairing power equipment and other component and parts; to make non-standard equipment and mechanized transportation devices; to make prototype machines and to do some innovation work.

2) Management Sections

Generally, the factory has the following eight sections, which can either be merged or separated in accordance with specific condition.

1. General Office --- It executes the director's decisions, deals with every day business, in charge of administration, general affairs, welfare services, etc.

2. Production Planning Section --- In charge of products' planning controlling, statistics, handling semi-finished products and blanks, to make production well-coordinated.

3. Supply and Sale Section --- In charge of supplying raw materials, fuels, purchased parts; managing warehouses and transportation; selling products and servicing for customers after-sale.

4. Technical Section --- In charge of product design, production technology, technologic innovation, collecting information, product development. If necessary and possible, a product research institute can be set up.

5. Quality Control Section --- In charge of examining products' quality, appraising measuring instruments; chemical and physical testing for materials; managing metrological laboratory and physical-chemical laboratories.

6. Personnel and Security Section --- In charge of labour salary, transfer of personnel, checking work attendance, system of reward penalty, guard, etc.

7. Power Plant Section --- In charge of working out plant maintenance plan, ensuring safety in production; and managing power plants such as trasnformer and distribution substation, electric power station, pump room, etc.

8. Finance Section --- In charge of the whole factory's financial affairs, receiving and paying out money, cost accounting, and loss and profit analizing.

3) Technology Choice and Equipment Disposition

1. Casting

A large amount of grey cast iron is often required on farm machinery, general machinery, and the parts repaired in the factory. Considering production is sometimes unbalanced, technology and equipment to be chosen must have a large margin of flexibility.

It is suitable to equip with a blast furnace, 2 tons/h. The chamber size of the furnace can be changed and adjusted for the amount of molten iron. If necessary, a molten iron ladle can be built in front of the furnace so as to fit for producing a big casting (2-4 tons/ piece).

Generally, the materials to be fed to the furnace are broken manually except the large steel scraps, which can only be done by gas cutting. Weighing and charging can be simply mechanized. Pouring molten iron is mainly by hand.

The malleable cast iron and steel castings required in production are purchased.

If you have a good command of the production technology of nodular cast iron, you can use nodular cast iron instead of casting steel.

The white cast iron required in tillers' parts can be made by permanent mold, for common grey cast iron by sand mold casting.

Big castings are formed on the spot, and medium or small ones formed in sand-box. When a large numbers of castings are required, jolt-type moulding machines are used.

Core is man-made, and drying is done by means of a stove.

Sand shake-out, sand mixture are done continuously by a combined unit.

Top risers and burrs are eliminated generally by hand or grinder after cooling.

Then the castings are put into a cleaning barrel or put in the open for natural ageing.

If necessary, the water tight test can be done for castings in order to examine its quality.

The woodworking group should be quipped with universal machines such as gig saw, planer, and tenoning machines.

The wood parts and pattern making wood must be treated by steaming, boiling or natural seasoning so as to keep the wood parts from cracking and deformation.

A pot furnace with 100 kg must be set up for melting the non ferrous metal to meet the requirements of production and maintenance.

The fuel for heating depends on local conditions.

According to the production task the operations of casting department can be done by turns.

The annual output of the shop can reach 400-500 tons or more.

2. Forging:

The forgings of farm machinery production and repair parts are characterised by: great variety, simple technology, and small lot, we should give priority to free forging and hand forging.

When the parts are in batches, 30-40 or more, stamp forging technology should be taken.

The forging pieces from bar stock (Ø 30 mm), steel plate, and sectional steel should be heated beforehand.

When the hand tools such as sickles, picks, axes, spades are in mass production, the special equipment should be used for specialized production.

The equipment required in forging shop, should mainly be chosen in complete set. The medium-sized multipurpose agricultural machinery plant is better to choose electric air hammers of three sizes: 400 kg, 150 kg and 65 kg, and a friction press (300 tons), which is able to forge a gear blank of diameter over 100 mm. Various cutter handles, thin bars can be forged on a 150 kg or 65 kg air-hammer, press forming of plate steel can be done on friction press after being heated; for example, small mouldboard, harrow etc.

As for big forge pieces, it will be better by punchasing, because it is uneconomic to do this in the plant.

Coal stove is often used for heating forge-blanks in China's farm machinery factories. According to local conditions, gas stove, electric stove, and oil stove can also do.

Forging blanks and bars used in machining are cut off with a hack saw at the steel materials store.

The annual output of the forging shop can reach 200 tons or more.

3. Punching and Pressing:

Most of stampings in farm machinery are made of steel sheet, and some of them only need cutting, pressing and punching, without any other machining. A few stamping need drilling and tapping, we can set up a table drill by the side of stamping machine.

Shears with capacity less than 6 mm or with capacity less than 10 mm and combined stamping-shearing machines could be used for material-blanking, three-roller mill for plane-checking or rounding; 60 tons stamping machine for forming. Tubes and section steels can be cut off with some simple tools such as hand tube cutters, hand shears. Tube bending with die blank could be done by manual cold working. The burrs and edges of stampings are eliminated by hand or grinder.

4. Welding:

The majority of parts are welded with A.C. electric welder. Sheets are welded with spot welder.

As for section steels, non-standard equipment or mechanized devices, a complete gas welding set is better to be used.

The rectification of welding deforming is done by hand.

For a batch production, different types of welding jigs can be used.

Welding operations must be separated according to working stands and some smoke and dust hood units must be set up.

5. Heat treatment:

Since the working parts of farm machinery, such as cutters, mouldboards, harrows and blades are usually working in bad conditions, high quality is required. So great attention must be paid to the choice of technology and equipment. Quenching and tempering are in box-type electric furnace, carburizing in well-type gas carburizing furnace, tempering in well-type electric furnace, quenching in flush-electrode salt bath furnace, case hardening in a medium-sized high frequency furnace. It is necessary to have a quenching machine. Low-temperature tempering oil tank is not only for tempering but for cooling, aqueous alkali tank for cleaning putty, hand press for rectification, various hardometers for hardness test. All the above installations and machines can do heat treatment for common structural steel parts, some dies and gears.

For one year the shop can treat about 300 tons' parts.

6. Machining:

For the changeable products, the conventional production technologies are used. The machining of the general parts mainly depends on universal machine tools. In order to extend machining range, some different technologic devices are attached.

Specialized machine tools must be used to machine special parts in large numbers, for instance, knives, blades, etc. For the mass production and high quality, a specialized production line could be set up.

Whichever technology or equipment is chosen, it must ensure high quality and good economy.

The box-type parts are generally made of grey-iron castings, for which the milling machine can do surface rough and precision machining. The boring machine or lathe can do roughing and precision boring, the drilling machine can do drilling and tapping. When the production lot is large, special boring machines, special planing machines, and special jigs are used for ensuring the quality. Sometimes a production line which consists of simple and special machine tools will be set up.

Dish-type and drum-type parts and small shafts are mainly machined with engine lathe.

Varied parts of cast-iron or steel are mainly machined with turret lathe and milling machine.

As for special major shaft-type parts or large diameter parts, universal machine tools with some supplementary attachments are used.

Large machine tools are not equipped.

On farm machinery, cast-iron gears, stamping gears or sprockets are not machined, but for gears for high speed power transmission is machining then.

So the madium-sized multipurpose agricultural machinery plant should be capable of machining gears. For individual or small number of spur gear or bevel gears and spline shafts can be machined on universal milling machine. It is necessary to be equipped with gear hobbing machine (m 4) and gear shapper for production. For steel gears, after heat treatment, gearing in should be undertaken to improve the meshing engagement. Complete set for spiral bebel gear or machines for making precision gears, such as gear-shaving machine and gear-grinding machine, are not equipped in the shop. The sizes and specifications of gear machines in the machining shop and in the repair shop should be well coordinated to ensure full utilization.

Appropriate different size of engine lathes and turret lathes are properly selected.

Milling machines should be equipped with different size of working tables. Moreover, vertical and horizontal universal milling machines are necessary. Shapers with 500 mm stroke and double housing planer with 800 mm in width, can meet the requirement of surface machining for box type parts of the most farm machinery products.

For grinding machine, medium and small-sized internal grinders, external grinders, and face grinders are adopted.

For drilling machine, a few different size upright drills, bench drills and radial drills are quite enough.

Boring machines and shapping machines are generally of medium and small size. The total universal machine tools in machining shop are around 30 units. In pace with the development of new products the multipurpose agricultural machinery plant should often add some special machine tools self-made and some sophisticated machine tools bought from outside.

7. Farm Machinery Repairing:

The repairing of farm machinery is usually seasonal. Machines delivered to the plant in a busy farming season are required to be repaired in time. In order to solve the problems of making supplementary components and immediate repair for damaged parts, a small number of universal machine tools and common gas welding and electric welding should be equipped in this shop. The seriously damaged parts can be repaired in machining shop or tooling and maintenance shop.

As for repairing tractors (including engines), the wear parts, such as crankshafts, connecting rods, camshafts, pistons, piston pins, piston rings, bushes, cylinder sleeves, valves, fuel pumps and hydraulic units in tractors etc. are mainly repaired by replacing with new spare parts. Some simple, cheap, effective and advanced repair technology such as viscose mending, sealing, gluing could be used for repairing some special parts as cylinder blocks, etc.

In this shop, the cleaning, dismantling and mending tables for various components, such as the group of piston crankshafts, cylinder head, gear box, oil pump, hydraulic system and chassis, should be set up in accordance with the quantity of repairing jobs.

Water test stand, hydraulic dynamometer, static balance unit, should be set up for the checking. The stands of hydraulic system, electric system, fuel pump system for repairing adjustment and testing should also be set up. For the sake of convienence, mobile dinamometer should be provided and should be sent to the farms for checking the performance of the repaired units.

Tyre mending is a problem we often meet in the rural areas. A complete tyre mending equipment should be set up in the repairing workshop, if there is no other special maintenance shop near the plant.

8. Tooling and Maintenance

Equipment disposition should ensure the ability of tool manufacturing and equipment maintenance for normal production, and the ability to renew products and making special equipment to meet the development of the factory. The precision of machine tools in this shop is higher than that in machining shop. The specifications of machine tools here, such as vertical lathes, boring machines, gear-hobbing machines, can be coordinated with that in machining shop.

Holes of products and equipment with higher precision should be machined with precision milling machine.

Generally, coordinate boring machines will not be equipped because of its low utilization.

Some precision parts and the complicated cutting tools could be purchased.

9. Assembling and Testing:

Products are generally assembled by hand. Large-sized products or large lot of products should be assembled with fixed tables. Medium and small-sized products can also be assembled with a common assembly line or fixed tables. According to the different requirements of products, the factory can make some special assembly benches or test rigs. Before assembling, component or parts should be cleaned, and putty and burrs should be eliminated.

The painting, both for components and whole machine, could be performed with hand spray painting, brush painting or immersion painting, and then by natural drying. The painting room must be separated independently. A painting mixer should be equipped.

10. Metrology, Chemical and Physical Examination:

In order to ensure measurement instruments in normal condition, and to standardize the system of weighing and measuring, some standard instruments should be provided for checking length, weight, temperature, electric instruments. The high precision instruments can be sent to the measurement examining organization nearby for checking.

Physical and chemical experiment instruments and equipment needed in materials testing and microstructure observing should be equipped.

4) Working System

According to China's conditions, in major machining shops, two-shift workday system is instituted. In the shops of assembling, testing, forging, welding, farm machinery repairing are adopting, one-shift workday system. Three-shift workday system is instituted in heat treatment. Casting department is periodical working and production in turns.

5) Personnel Assignment

For basic production workers are assigned into groups for the key equipment workers are assigned to post. Worlers are asked to be an expert in one thing and good at many and also to be a "many-sided person" to meet the changeable requirements of products. According to Chinese eight technic-grade-system, the average grade of workers in multipurpose agricultural machinery plant should be above 4th grade.

In order to strengthen the capability for product design and improvement of production technology, and to meet the needs of production management, the factory must have a certain proportion of engineers and technicians, about 4-6 percent of total staff.

6) Factory Building

In the factory building, we should consider these important factors such as; the local conditions for constructing, the convenience for production and lowering the building cost.

Generally speaking, hot working shops are built independent with other, while cold working shops are merged into one building so as to reduce materials transportation and to make production units close by. In designing buildings,

the great attention must be paid to unified the construction parameters, such as column distance, span, and height, etc. As for reconstructing the old factory, we should order the overall planning study the particular problems and make rational use of the old buildings.

7) Public Facilities

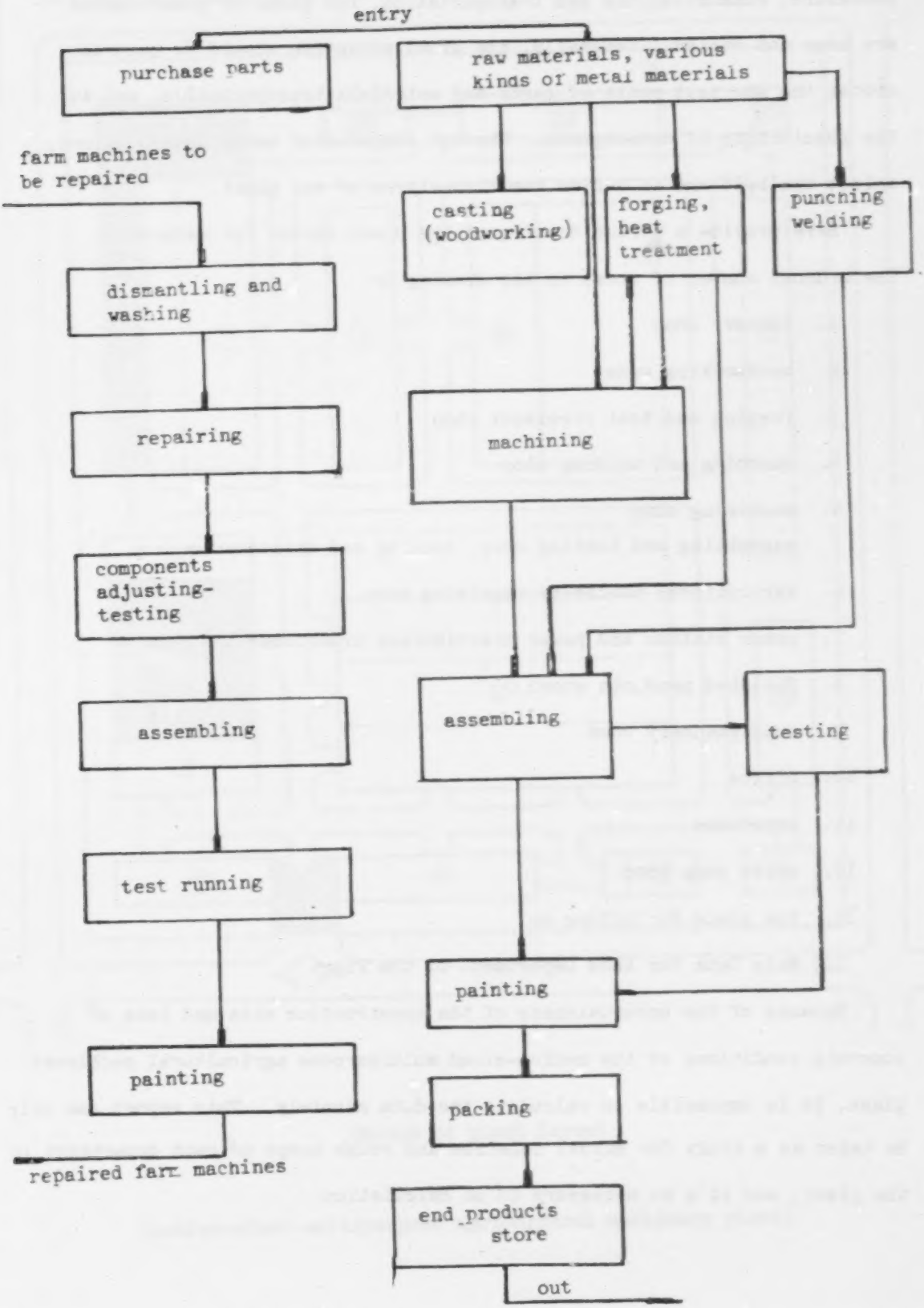
Since the electricity supply condition is not same in different localities, a spare diesel generator, with capacity about 30 percent of total power required is necessary in order to ensure safety in production.

According to local fuel resources, coal, oil, natural gas or electric may be used for heating process. Steam will not be used in production. As the amount of compressed air required is not large, it will not set up an air compression station, a movable air compressor is quite enough. In order to get the water required for production and livelihood, a water pump room or a water tower (or a high level water pool) should be built, if no utility water is available. Drainage problem will be solved on the basis of local conditions.

Business offices and living welfare facilities within the plant district should be under unified planning. The living welfare, culture and education facilities outside the plant district are handled by local society, so the items and cost of living quarters, public dining room, nursery, kindergarten are not included in this program.

6) Production Route

Production routes of general products and farm machinery repairing are as following:


entry
purchase parts
raw materials, various kinds of metal materials
farm machines to be repaired
casting (woodworking)
forging, heat treatment
punching welding
dismantling and washing
repairing
machining
components adjusting-testing
assembling
assembling
testing
test running
painting
painting
packing
end products store
out
repaired farm machines

9) Plant Layout

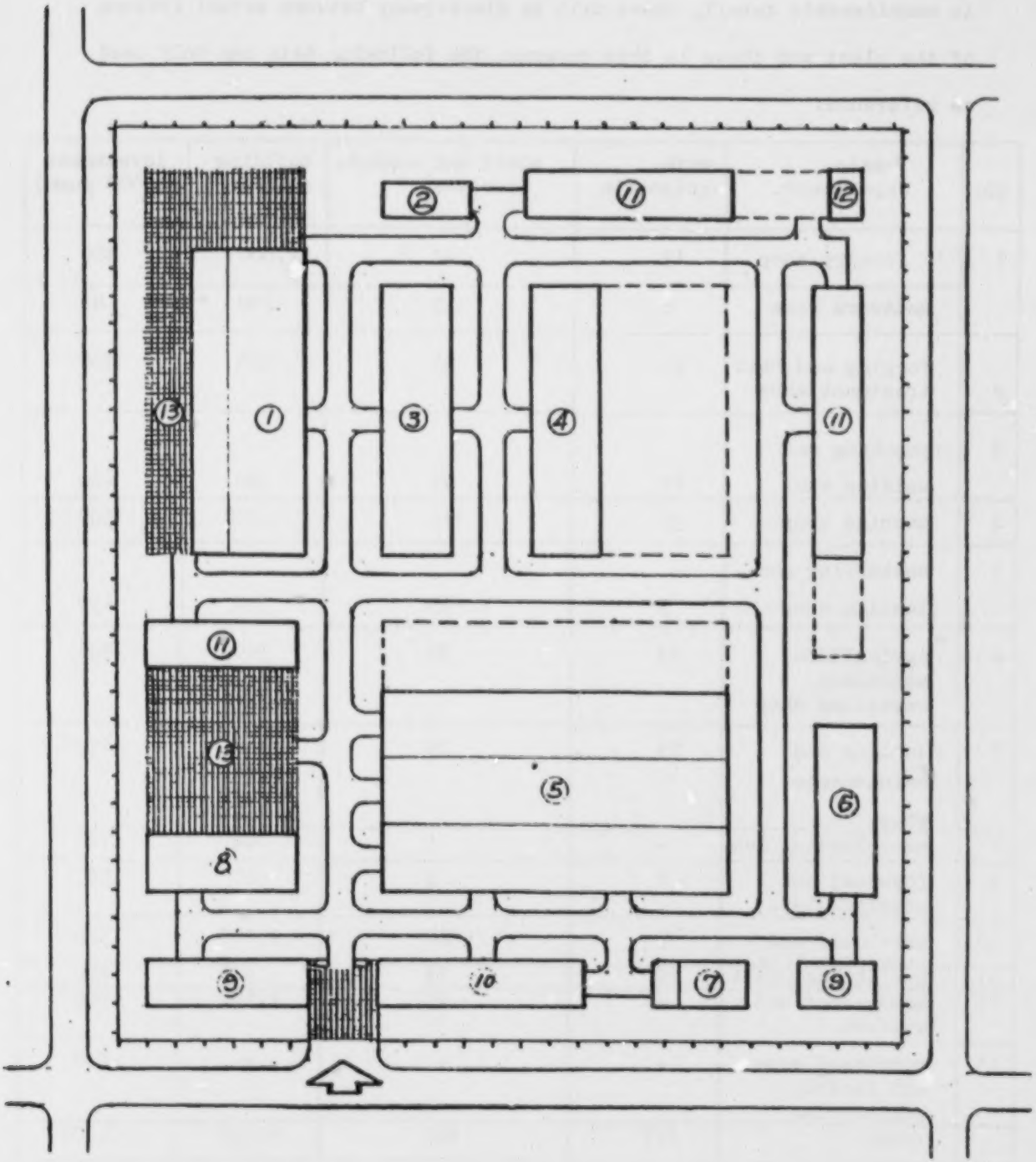
In line with the factors of organizations, topography, production procedure, communications and transportation, the plans of plant-layout are many and varied. Generally, the great attention should be paid to choose the shortest route of parts and materials transportation, and to the possibility of development. Through comparision among amany options, select the best one to define the disposition of the plant.

Here provide a sketch drawing of the plant-layout for reference. The ordinal number of items in the drawing is:

1. foundry shop
2. woodworking room
3. forging and heat treatment shop
4. punching and welding shop
5. machining shop
   assembling and testing shop, tooling and maintenance shop
6. agricultural machinery repairing shop
7. power station and power distribution transformation room
8. finished products store
9. supplementary room
10. office
11. warehouse
12. water pump room
13. the place for piling up

10) Main Data for Each Department of the Plant

Because of the uncertainness of the construction site and lack of concrete conditions of the medium-sized multipurpose agricultural machinery plant, it is impossible to calculate the data minutely. This report can only be taken as a study for mutual relation and rough scope of each department in the plant, and it's no necessary to do calculation.



Sketch of plant layout

(medium-sized multipurpose agricultural machinery plant)

in considerable detail, there will be discrepancy between actual factors of the plant and those in this program. The following data can only used as reference:

no.	main departments	main equipments	staff and workers (persons)	building area (m^2)	investment (1000 yuan)
1	foundry shop	13	42	1,000	300
	woodwork room	5	5	200	80
2	forging and heat treatment shop	20	35	460	300
3	punching and welding shop	12	27	500	180
4	machine shop	32	115	1,000	500
5	assembling and testing shop	5	35	500	150
6	agricultural machinery repairing shop	14	30	360	350
7	tooling and maintenance shop	19	25	360	170
8	metrological lab.	-	3	60	100
9	physical and chemical lab.	2	5	60	50
10	warehouse and transportation	5	20	2,000	320
11	public facilities	10	13	300	160
12	management and welfare	-	65	1,500	300
13	purchased area and factory engineering	-	-	-	240
	total	137	420	8,300	3,300

11) Main Data of the Whole Plant

Annual Output: (according to mixed units of representative products)	5000 units
Annual Production Weight (according to mixed units weight of representative products)	500 tons
Annual Total Value of Output (according to representative products, including farm machinery repair)	5 million yuan
The Total Number of Main Equipment:	135-140 units
of which machine tools:	45-50 units
forging and punching machines	12-15 units
The Total Number of Stuff and Worker:	400-450 persons
of which workers:	310-340 persons
Total Equipment Installation Capacity:	550-600 kw
Site area of the plant:	2.0-2.5 hectare
Building Area of the Plant	8000-8500 m^2
Annual Consumption of Essential Materials:	about 1000 tons
of which steel:	about 200 tons
pig iron	about 600 tons
Estimate of Capital Construction Investment (excluding the constructions outside the plant):	3-3.5 million yuan

III) An Approach to the Planning of Small-sized Multipurpose Agricultural Machinery Plant

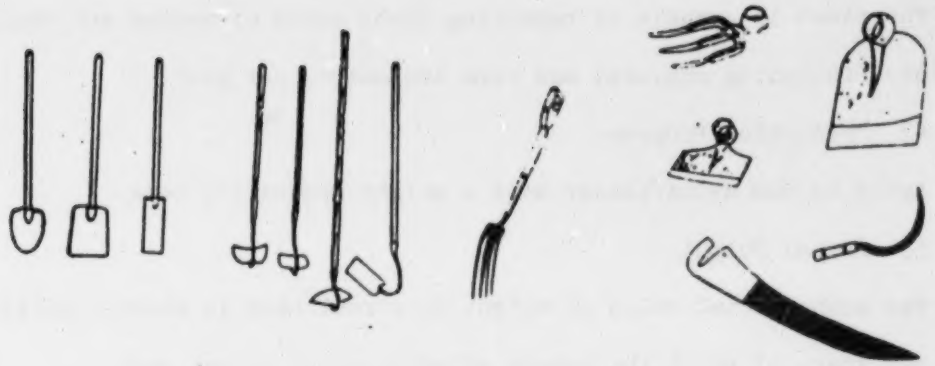
1. Production Task and Construction Scale

1) Service Range: According to the concrete situations, a small country which occupies the cultivated area about 30,000 hectares is taken as the service object of a small-sized multipurpose agricultural machinery plant. The plant should be able to produce the main machinery equipment required in agricultural production and to provide some allied equipment and repair services for rural construction and peasants livelihood as well.

2) Representative Products

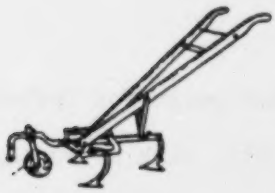
1. hoe, shovel, spade, sickle, axe, etc. operated by hand
2. animal-drawn sigle-bottom plow
3. small-size animal-drawn cultivator
4. small-size animal-drawn drills
5. pedal or dual-purpose thresher
6. small rice and flour mill
7. small-size pump

Sketches of the Products on the Attached Sheet

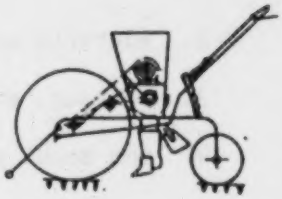


①

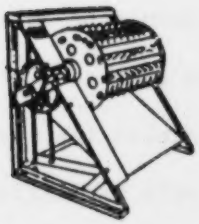
②



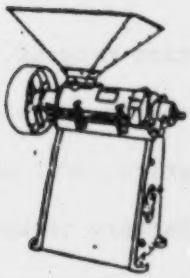
③



④



⑤



⑥

⑦

3) Assignment for Repairing Agricultural Machinery

The plant is capable of repairing 60-80 units of medium and small-sized tractors (including engines) and farm implements per year.

4) Production Program

About 40,000 units/pieces with a weight around 330 tons.

5) Annual Output

The annual total value of output in normal case is about 2 million yuan per year, of which the repair value is about 15 per cent.

6) Some Ancillary Component Parts to be Purchased

1. engines required
2. electric motor
3. bearing, standard parts for fastening, chain, oil seal, etc.
4. non metal products, such as rubber, leather, plastics, etc.
5. large iron casting malleable cast iron and nodular cast iron
6. repairing for precision machine
7. oxygen for gas cutting

2. Plant Planning

According to above production program, the plant should be equipped with fairly complete type of work in workshops and with good adaptability to making different types of agricultural machinery and also the machines with similar material and manufacture technology, and with facilities for renewal of products, for making proto-types and for reforming factory through self-reliance.

1) Production Departments

Under the plant, there are five main production workshops

1. Foundry shop --- the task is to produce iron castings and non-ferrous metal castings used in products and maintenance equipment of this plant.

Under the workshop there are groups: melting, moulding, cleaning, nonferrous metal casting and woodworking. The woodworking group can not only make wood pattern but also provide wood parts for products packing and building maintenance.

2. Hot-working shop --- including forging, punching, welding and heat-treatment groups for products, tools and machine repair.

3. Machining and Assembling Shop --- including machining, assembling, testing and painting.

4. Farm Machinery Repair Shop --- it ought to be able to repair and to adjust medium and small sized tractors and various kinds of farm machines.

5. Tooling and Maintenance Shop --- it should be able to make cutting tools, measuring devices, supplementary holders, jigs, fixtures, patterns, moulds and ordinary equipment; to make accessories for repairing power equipment and other parts for non-standard equipment and mechanized transportation devices; to make proto-type machines and to do some innovation work.

2) Management Department

Generally, the factory has the following six sections, which can either be merged or separated in accordance with specific condition.

1. General Office --- it executes the director's decisions, deals with every day business, in charge of management, adjustment, general affairs, welfare services, etc.

2. Production Planning Section --- in charge of products' planning controlling, handling statistics, semi-finished products and blanks, to make production well-coordinated.

3. Supply and Sale Section --- in charge of supplying raw materials, fuels, purchased parts; managing warehouses and transportation; selling products and servicing for customers after-sale.

4. Technical Section --- in charge of product design, and development production technology, technologic innovation, quality control, machine maintenance, collecting information, etc. managing metrological lab. and physical-chemical lab.

5. Personnel and Security Section --- in charge of labor salary, transfer of personel, checking work attendance, system of reward, penalty, guard, etc.

6. Finance Section --- in charge of the whole factory's financial affairs.

3) Technology Choice and Equipment Disposition

1. Casting: A large amount of grey cast iron is often required on farm machinery, general machinery and the repairing parts in the factory. Among them box casting, machine body and frame parts constitude the majority. Most gears used for farm machienry are also castings.

Considering production is sometime unbalanced technology and equipment to be chosen must have a large margin of flexibility.

It is suitable to equip with a blast furnace 1.5 tons/h. when the casting quantity in production is changed, the camber size of the furnace can be changed and adjusted accordingly. If necessary, a molten iron ladle can be built in front of the furnace so as to fit for producing a bigger casting.

Generally, the materials to be fed to the furnace are broken manually except the large steel scraps which can only be done by gas cutting.

Weighing, charging and pouring molten iron are mainly by hand.

The common grey cast iron will be made by sand mold casting, sandbox modelling or on-site-molding casting. The white cast iron required in tillers' parts can be made by permanent mold for chilled casting.

Core is man-made, and drying in open air.

Top risers and burrs are eliminated generally by hand or grinder after cooling.

Sand shake-out and sand mixture are done by a combined unit. Then the casting are put into a cleaning barrel or put in the open for natural ageing.

A pot furnace with 50 kg must be set up for melting the nonferrous metal to meet the requirements of production and maintenance.

The woodworking group should be equipped with universal machines such as gig saw, planer and tenoning machines. The wood parts and pattern making wood must be treated by boiling or natural seasoning to keep the wood parts from cracking and deforming.

The annual output of the foundry shop can reach above 250 tons.

2. Forging: Many manual and animal drawn implements are forgings. We should give priority to free forging and hand forging for the small-batch production. Sometimes stamp forging may be properly used. For some large sized section material, press forming can be done after being heated. The small-sized maultipurpose agricultural machinery plant is better to choose electric air hammer with capacity 150 kg and 65 kg, and a friction press (160 tons). Hand-forging anvil may be provided to meet the requirement of the odd jobs and tool forging.

The annual output can reach 150 tons or more.

3. Punching: Most of stampings in farm machinery are made of steel sheet, and some of them only need cutting, pressing and punching, without any other machining. Some parts, the quantity of which is great and the machining is very difficult, will be purchased. Combined punching-shearing machine, punching machine with capacity 30 tons, three-roller mill as well as many other shearing and forming tools/die bolcks may be used for the punching operations.

4. Welding: The majority of parts are welded with A.C. electric welder. A complete gas welding set is better to be used. The rectification of welding deforming is done by hand. For a batch production, different types of welding jigs can be used.

5. Heat-treatment: In order to meet the requirements of the parts made of carbon steel and for the operation of quenching, tempering, normalizing and carburizing, it is necessary to use box-type electric furnace, well-type electric furnace and well-type gas carburizing furnace. The oil troughs and and water troughs can be used for hardening, cooling and low-temperature tempering. After heat-treatment, if necessary, the rectification of parts should be operated on the hand-press. Various hardometers for hardness test must be used. About 100 tons of parts can be treated per year.

6. Machining: For the changeable products, the conventional production technologies are used. The machining of general parts mainly depends on universal machine tools. In order to extend machining range, some different technologic devices are attached, the special parts with large lot would be machined by simple special machine tools.

The box-type parts are generally made of grey iron castings, for which milling machine can do surface roughing and precision machining, lathe can do roughing and precision boring, drilling machine can do drilling and tapping. The large box-type parts used for equipment maintenance should be machined on the small-sized double housing planer.

The general dish-type parts and small shaft-pin-like parts are mainly machined by lathe.

Varied parts of cast iron or steel parts are mainly machined with turret lathe and milling machine.

As for special major shaft-type parts or large diameter parts, universal machine tools with some supplementary attachments are used.

As for a few common gears hobbing machines may be used well coordinating with the equipment in tooling and maintenance shop.

The metal cutting machine tools used in the shop are of medium and small size in terms of specification and of common precision. Large machine tools are not equipped.

7. Assembling, testing and painting: Products are generally assembled by hand. Large-sized products or large lot of products should be assembled with fixed table. Adjusting and testing of components or whole machine should be carried out on the fixed table and position.

The painting both for components and whole machine could be performed with hand spray-painting, brush-painting or immersion painting and then by natural drying.

8. Farm machinery repairing: The repairing of farm machinery is usually seasonal. Machine dilivered in a busy farming season are required to be repaired in time. In order to solve the problem of making supplementary components and immediate repair for damaged parts, a small number of universal machine tools and common gas welding and electric welding should be equipped in the shop. The serious damage parts can be repaired in machine shop or tooling and maintenance shop.

As for repairing the medium and small size tractor (including engines), the wear parts, such as crankshafts, connecting rod, camshafts, pistons, piston pins, piston rings, bushes, cylinder sleeves, valves, fuel pumps and hydraulic units in tractors, are mainly repaired by replacement.

In the shop, the cleaning talbe, dismentling and mending tables for various components, such as the group of piston crankshafts, the cylinder head, gear box, the group of oil pump, hydraulic system and chasis, should be set up in accordance with requirements. Water test stand, hydraulic dynamometer, static balance unit should be set up for the checking. The stands of hydraulic system, electric system, fuel pump system for repairing, adjusting and testing should also be set up.

Some simple, cheap, effective and advanced repair technology such as viscose mending, sealing, gluing connecting could be used for repairing some special parts as cylinder blocks, etc.

For the sake of convenience, mobile dynamometer should be provided and should be sent to the farms for checking the performance of the repaired units.
A simple complete but mending equipment should be set up in the repairing workshop.

9. Tooling and maintenance: Equipment disposition should ensure the ability of tools manufacturing and equipment maintenance for production, and the certain ability to renew products and manufacturing special equipment to meet the development of the factory.
The precision of machine tools in the shop is higher than that in the machining shop. The specifications of machine tools here, can be larger than that in the machining shop. Boring machine and gear-hobbing machines must be coordinated with that in machining shop. Some precision parts and the complicated cutting tools could be purchased.

10. Metrology and chemical and physical examination: In order to ensure measurement instrument in normal condition, and to standardize the system of weighing and measuring, some standard instruments should be provided for checking length, weight, temperature and electric instruments.
Common physical and chemical experiment instruments and equipment needed for materials testing and microstructure observing should equipped.
The high precision instruments can be sent to the measurement examining organization for checking.

4) Working System

According to China's conditions, in major machining shops two-shaft workday system is instituted. In the shops of assembling, testing, forging, welding, farm machinery repairing are adopting one-shift workday system. Three-shift workday system is instituted in heat-treatment, casting department working is periodical and production in turns.

5) Personnel Assigned

For basic production workers are assigned into groups; for the key equipment workers are assigned to post. Workers are asked to be an expert in one thing and good at many and also to be a "many-sided person" to meet the changeable requirements of products. According to Chinese workers eight-technic-grade system, the average grade of workers in multipurpose agricultural machinery plant should be above 3-4th grade.

6) Factory Building

In factory building, we should consider the following important factors: the local conditions for construction, the convenience for production and lowering the building cost.

Generally speaking, hot working shops are independent with other buildings, while cold working shops are merged into one building so as to reduce materials transportation and to make production units close by. In designing buildings, the great attention must be paid to unify the construction parameters such as column distance, span and height etc. As for reconstructing the old factory, we should, under the overall planning, study the particular problems and make rational use of the old buildings.

7) Public Facilities

This plant lies mostly near the rural area where the power supply conditions are different from one another. A stand-by diesel generation set, with capacity about 30 percent of total power required is necessary in order to ensure safety in production.

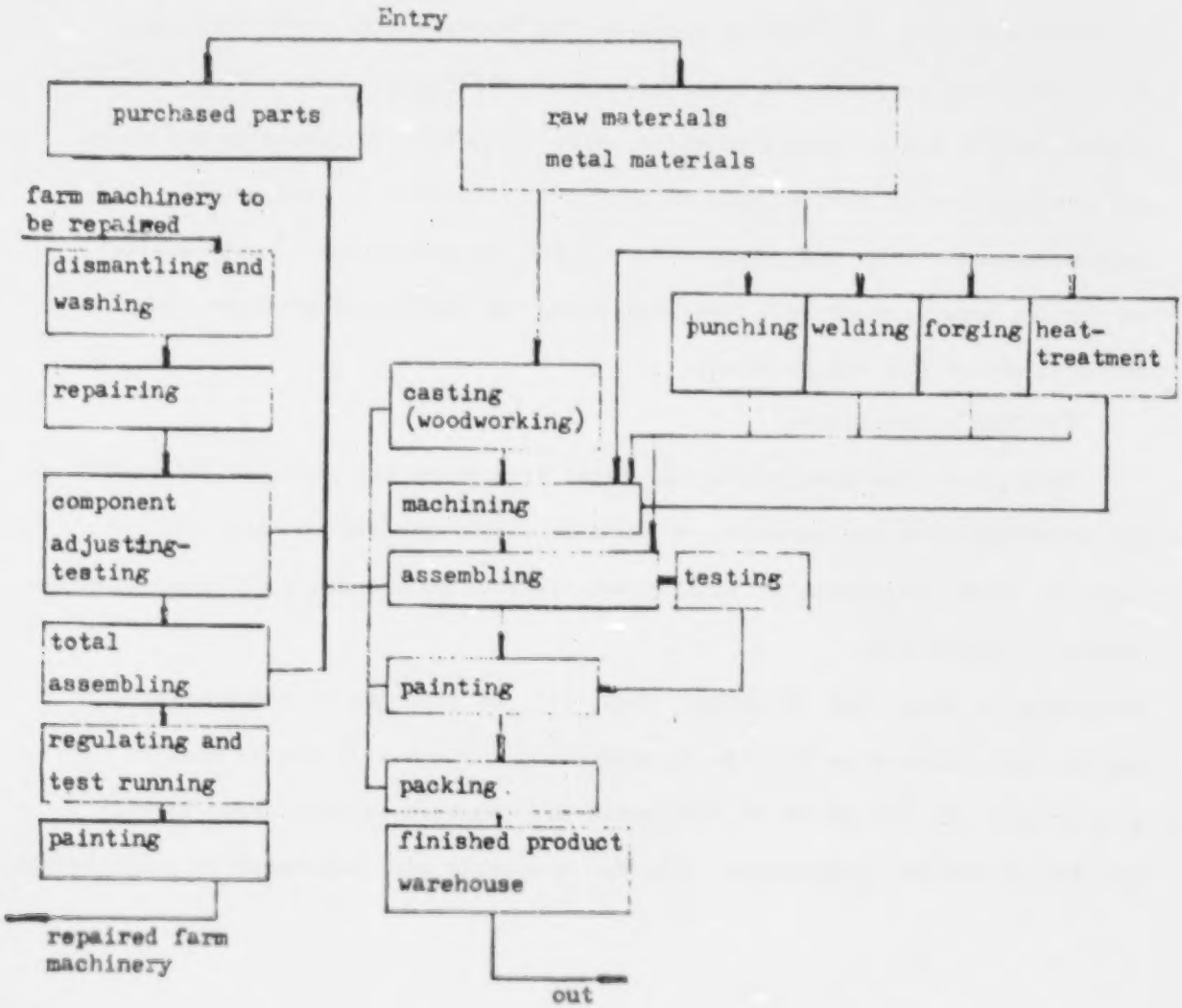
According to local fuel resources, coal, oil, natural gas or electricity may be used for heating process in production. Steam will not be used in production. As the amount of compressed air required is not large, it will not set up and air compression station, a movable air compressor is quite enough.

In order to get the water required in productionand livelihood, a water pump room or a water tower (or a high level water pool) should be built. Drainage problem will be solved on the basis of local conditions.

Business offices and living welfare facilities within the plant district should be under unified planning. The living welfare, culture and education facilities outside the plant district are handled by local society. So the items and cost of living quarters, public dining room, nursery, kindergarten are not included in the program.

8) Production Route

Production routes of general products and farm machinery repairing are as following:



9) Plant Layout

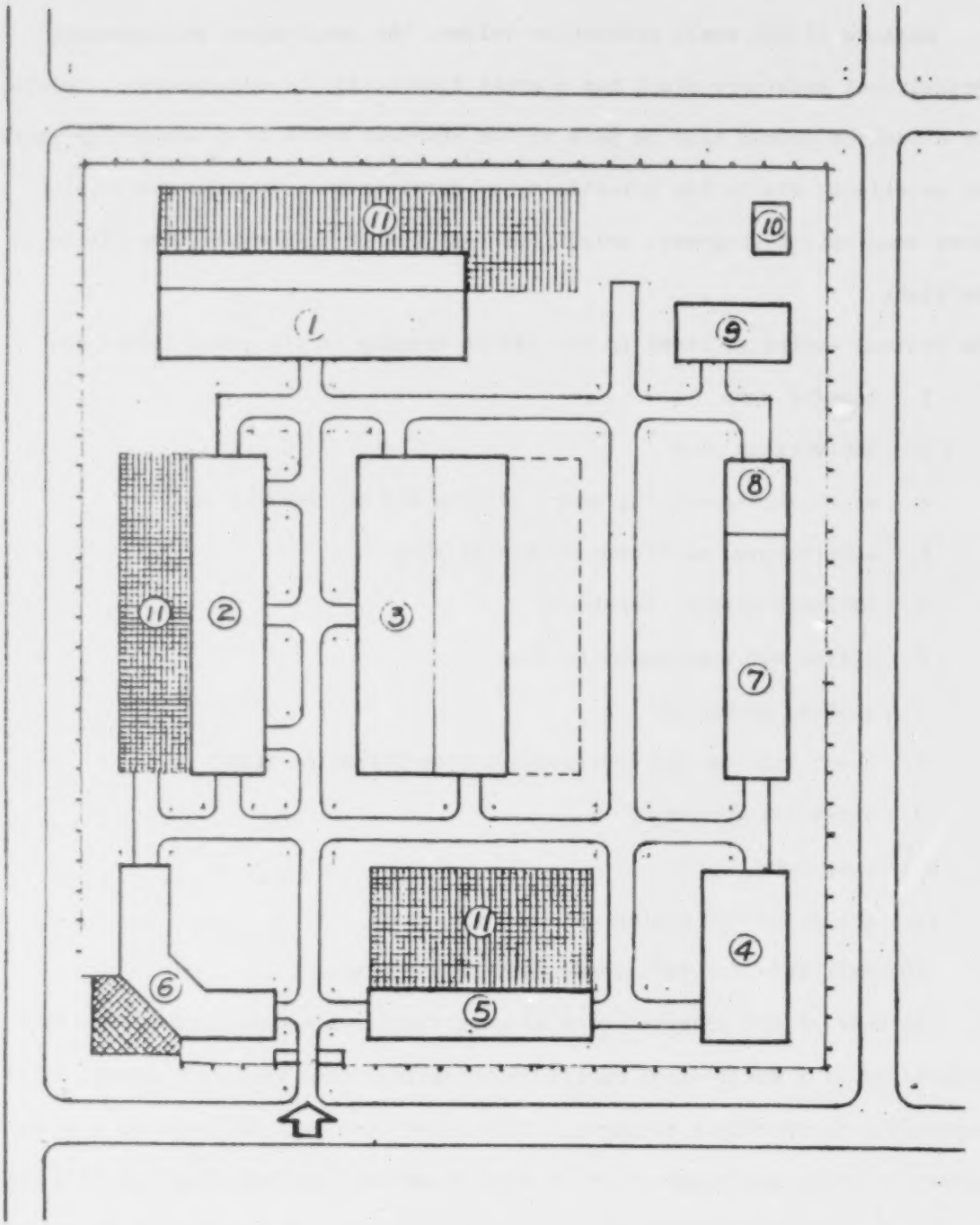
Because of the small production volume, the small-sized multipurpose agricultural machinery plant has a great flexibility in arrangement. Generally, our attention should also be paid to the shortest route of transporting parts and materials, and to the possibility of development. Through comparision among many option programs, select the best one to define the disposition of the plant.

The ordinal number of items in the sketch drawing of the plant layout is:

1. foundry shop
2. hot-working shop
3. machining-assembling shop, tooling and maintenance shop
4. agricultural machinery repairing shop
5. finished product warehouse
6. office and supplementary room
7. general warehouse
8. power station and distribution/transformation room
9. woodworking room
10. pump room
11. the place for piling up

10) Main Data for Each Department of the Plant

Because of the uncertainness of construction site and lack of concrete conditions of a small-sized multipurpose agricultural machinery plant, it is impossible to calculate minutely. This report can only be taken as a study for mutual relation and rough scope of each department in the plant and it's not necessary to do calculation in considerable detail. There will be discrepancy between actual factors of the plant and those in this program.



Sketch of plant layout

(small-sized multipurpose agricultural machinery plant)

No.	main department	main equipment	stuff and worker(persons)	building area (m^2)	investment (1000 yuan)
1	foundry shop	10	35	600	200
	woodwork room	4	4	120	50
2	hot working shop	24	32	600	290
3	machining-assembling shop	27	78	1000	400
4	agricultural machinery repairing shop	15	20	300	150
5	tooling repairing shop	10	22	300	240
6	metrological lab.	-	3	50	80
7	physics-chemistry laboratory	2	4	50	40
8	warehouse and transportation	5	15	1200	180
9	public facilities	8	10	300	100
10	management and welfare	-	40	1000	160
11	purchased area and factory engineering	-	-	-	210
	total	105	253	5520	2,100

11) Main Data of the Whole Plant

Annual output: (according to mixed units of representative products)	40,000 units/pieces
Annual production weight: (according to mixed units weight of representative products)	330 tons
Annual total value of output: (according to representative products, including farm machinery repair)	about 2 million yuan
The total number of main equipment:	100-110 units
of which machine tools:	35-40 units
forging and punching machines:	10-13 units
The total number of stuff and workers:	240-260 person
of which workers:	170-190 person
Total equipment installation capacity:	400-450 kw
Site area of the plant:	1.2-1.8 hectare
Building area of the plant:	5,000-5,500 m^2
Annual consumption of essential materials:	about 400 tons
of which steel:	about 150 tons
pig iron:	about 200 tons
Estimate of capital construction investment: (excluding the construction outside the plant)	2-2,2 million yuan

IV. Conclusion

The two design approaches in this paper present fairly complete and reasonable concept representing the general characters of multipurpose agricultural machinery plant. Some important points pertinent to the design of multipurpose agricultural machinery plant are discussed on purpose to offer samples which might be useful to those who are intending to build a plant of this kind.

These designs are worked out on the basis of China's practical conditions. For example, the investment for capital construction are only corresponding to China's current economic situation, and price policy. Besides, the speed of development of different plants, even of same scale, is varying owing to the differences in management competence and governmental support. In other words, whether a multipurpose agricultural machinery plant will meet with success in construction,operation, and development is affected by many and varied factors.

It is of great significance that a thorough investigation of both technical and economical feasility should be made in advance of projecting a plant. Effective government policy is of particular importantance to the development of multipurpose agricultural machinery plant.

V. Some Issues to be Discussed

The following issues are deemed worthwhile to be discussed on this meeting.

1. The range of functions and the prerequisites for construction of the multi-purpose agricultural machinery plant.

2. Relationship between the construction of multi-purpose agricultural machinery plant specialized production plant.

3. Rational system and method for repair of agricultural machines.

4. Appropriate measures to ensure good economic results for multipurpose.

5. Enhancement of international coorperation and promotion of construction of multi-purpose agricultural machinery plant.

Distr.
LIMITED

ID/WG.449/3
19 September 1985

ENGLISH

United Nations Industrial Development Organization

Expert Group Meeting on the Development of
Multi-purpose Agricultural Machinery Plants

Guangzhou, P.R. of China, 13-18 November 1984

EXPERIENCES IN THE DEVELOPMENT OF MULTI-PURPOSE AGRICULTURAL MACHINERY PLANTS *

prepared by

Wang Wanjun**

and

Liu Hong-shu***

---

* This document has been reproduced without formal editing.

** Chinese Academy of Agricultural Mechanization Sciences (CAAMS), Beijing

*** The 4th Institute of Plant Design and Research, Beijing

V.85-31047

Table of Contents

		Page
I.	Introduction	3
II.	The history of the agricultural machinery plant has witnessed the necessity and the inevitability of "multi-purpose"	5
III.	Points of importance to the establishment and operation of "multi-purpose" agricultural machinery plants	8
IV.	Conclusion	17

I. Introduction

1. One of the major functions of UNIDO is to provide assistance to developing countries in the promotion and acceleration of their industrialization, in particular in the development, expansion, modernization, and operation of their industries including agro-industries and basic industries.

With the purpose of expediating the solution of the food problems, tc assist developing countries to establish agricultural industries, to provide sufficient agricultural machines and implements of good quality in fairly rich assortment, and to take this as starting point for developing national or local industries is a strategy of great significance. In this respect, UNIDO has been proceeding with numerous fruitful activities including consultation conferences, a series of meetings on international cooperation and exchange of experience in the field of agricultural machinery industries; seminars on R & D of agricultural machinery; training courses for personnel to meet specific needs; technical-economical cooperation, etc. All these helpful activities have drawn great attention of many countries and yielded positive results.

2. In order to promote agricultural machinery industries and allied industries more effectively in the light of specific conditions of developing countries, a proposal concerning multi-purpose production and service was put forward on the Second Consultation on the Agricultural Machinery Industry held in Vienna, October 1983, that the agricultural machinery plant should diversify its production and service by integrating manufacture of agricultural machinery products with allied capital goods. After extensive discussion, the participants recognized the establishment of multi-purpose agricultural machinery plant to be a worthwile approach for developing countries. It will promisingly meet the diversified needs for agricultural production and rural construction, as well as allied sectors. In this

connection, the Second Consultation confirmed the proposal concerning the development of multi-purpose agricultural machinery plant and recorded it in the Consultation Report.

The Fourth General Conference of UNIDO held in Vienna, 2--18 August 1984, put forward a proposal concerning industrial policies and means which is important for developing countries to accelerate their rural development and to achieve self-sufficient food supply. To carry out " multi-purpose " approach will certainly contribute to the fulfilment of this proposal.

Considering the necessary follow-up of the proposal, UNIDO resolved, after consultation with interested parties, that a panel meeting will be held in China. The experts will investigate the experiences in the development of multi-purpose agricultural machinery plant in China, exchange of experiences, and go further into the approaches and steps for the realization of the proposal.

3. For years, China has accumulated to a certain extent experiences in the development of agricultural machinery industry. Further, along with the development of agricultural production and rural construction, the agricultural machinery industry is changing and evolving. However, practices over a long period of time shows that the " multi-purpose " is a correct orientation, and an inevitable result as well.

China now has nearly 2,000 of small- and medium-scale agricultural machinery plants at county level, varied in scale and characteristics in line with local conditions, spreaded all over the country. The layout of some plants appear evidently less rational from a modern viewpoint due to some restrictive factors left over by specific historical conditions. Consequently it is difficult to take one or two plants as ideal representative models. After investigation and study of a number of plants, the authors of the documents present two layouts, one for each, of small- and medium-scale plant. The layouts are worked out on the basis of summing up the characteristics and experiences of numbers of plants

with the aim of submitting a kind of reasonable layout to be discussed on the meeting.

The first document systematically introduces the common experiences of importance in the development, construction, management, and service of the multi-purpose agricultural machinery plants.

The second document elaborates the two layouts in detail.

4. It is necessary to mention a second time that these documents are prepared on the basis of China's practical experiences which can be only for reference for other countries, because the societal, economic, and agricultural conditions are different from country to country and place to place. As you experts here know very well, the detail design of a plant must be, and only can be worked out in line with the specific requirements and conditions of the locality.

II. The history of the agricultural machinery plant has witnessed the necessity and the inevitability of " multi-purpose "

5. China is a developing country with a population of one billion an cultivated land only around 100 million hectares. The development of agricultural machinery industry has been extremely a complex task owing to the limited per capita farmland, historically weak foundation of industry, and great diversities in nature and economic conditions from place to place over the country.

Before Liberation, China has practically no agricultural machinery industry at all. Blacksmiths in villages and towns provided peasants with simple handmade tools such as hoes, sickles, etc.

Only after the founding of New China, has the government started to encourage the production of improved human-operated

and animal-drawn implements, and then proceeded to develop and produce motorized agricultural machinery. Up to now, China has approximately 2,000 agricultural machinery plants at county level for both manufacture and repair service in addition to a certain number of large-scale or specialized tractor plants and agricultural machinery plants. Most of these small- and medium-scale plants have grown up on the basis of united individul or collective blacksmiths' shops and other workshops. Despite the simple and crude equipment and the primary technology they had at their initial stage, these plants have been growing in scale and now are capable of producing agricultural machines and implements of thousands of categories in various sizes. Besides, these plants also provide services for more than 3 million existing agricultural tractors, big or small. In a word, they have significantly contributed towards the agricultural production and become the sound base of China's agricultural machinery industry.

6. Agricultural machinery plants at the grass-roots have been forging still ahead in the past few years

The newly applied agricultural policies, especially the job responsibility systems, have highly brought the initiative of peasants into play. As a result, agricultural production are increasingly developing both in depth and in scope. The peasants not only do planting, but also do foresting, fishing, animal raising, agricultural and side-line product processing, transportation, and, in fact, all kinds of undertakings which are of vital importance to the rural construction and development. Seeing that these plants might be almost the only machinery plants in the rural areas of China, the government calls for " producing whatever the peasants need ", not only varieties of agricultural machinery and implements, but also allied capital goods and even household appliance. Such being the case, the implication of the word " multi-purpose " has been further enriched.

7. "Multi-purpose" is an effective measure to solve the problem of imbalance of production caused by the seasonal fluctuations of agricultural machinery market. The planning personnel of the plants used to be troubled with this kind of fluctuation or imbalance. Now things are different, however, the plants have ample work load in the slack season of production of agricultural machinery. They are busy to produce allied capital goods and household appliance, especially the products which can be produced with equipment and labor having surplus capacity. To make full use of the existing production capacity may bring about to the plants notable economic results. China's agricultural machinery plants make the most of their " multi-purpose " function while serving the agriculture first. A number of plants, sometimes, have their output value and profit of products other than agricultural machines make up a larger proportion of the total, thus promoting the production of agricultural machinery instead of weakening it.

8. "Multi-purpose" is essential to the up-grading and expension of agricultural machinery plant itself. Almost all of the agricultural machinery plants have developed from small to large. Only when the plants have a capacity to produce manifold agricultural machines as well as allied capital goods, can they satisfy the diversified demands of the society and, in the same time, progressively equip themselves with additional equipment and technology at higher level. The " multi-purpose " approach is essential to a plant to maintain self-reliance and grow from strength to strength, and to serve as a " nucleus " for building up indigenous industry.

9. The management ability and service quality have been improved through the practice of operation of " multi-purpose " plant. In the past, all the activities of production of China's agricultural machinery plants were channeled into with the plans of responsible departments at corresponding levels. The plants simply carried out production work without concerning to diversify product categories, or to market their products. The products of the plants were somewhat monotonous and

production management was uncomplicated. However, the policies of today stipulate that rely mainly upon the planned economy while making market economy subsidiary. The peasants, the customers, will act on their own initiative, and buy whatever machines and implements they think appropriate with their own money. Such a pressing situation requires much changes and improvements to be made in the field of market investigation, new product development, planning, management, after-sale service, etc. The improvements in management and administration enable numbers of plants to manifest the superiority of the " multi-purpose " approach which leads the output value and profit to increase year by year.

10. The function and scale of agricultural machinery plants vary from place to place. It is impossible to have an unique model for them all. Take Guangdong Province, the site of this meeting, for example, in 1982 there are 99 agricultural machinery plants at county level. An average of them has about 226 staff and workers, 4,800 square metres of floor areas; 52 machine tools and forging equipment; fixed assets(net) amount to 870,000 yuan; yearly consumed steel 260 tons and pig iron 120 tons. The average productivity in 1982 was 3,854 yuan/person.

Analyses of selected plants to be visited during this meeting are shown in table 1 and 2.

III. Points of importance to the establishment and operation of " multi-purpose " agricultural machinery plant

11. The effective government policies and supports are the key prerequisits for establishing multi-purpose agricultural machinery plants. Chinese government has attached great importance to agriculture and agricultural mechanization since the founding of new China and has given a number of instructions or watchwords such as " agriculture is the fundation of national economy ", " the fundamental way out

for agriculture lies in mechanization ", and so on. The government also has formulated a whole set of policies for promoting agricultural machinery. For example, for implementing the government policy issued in the 50's that each and every county throughout the country should have agricultural machinery plant, numerous county-level tractor and agricultural machinery repair plants/stations were set up, of which grew out numbers of multi-purpose agricultural machinery plants. At the initial stage of the construction of agricultural machinery plants, the government provided the requisite funds and brought the construction of plants into line with the state capital construction plan. Moreover, the government provided the plants in all parts of the country with necessary equipment in spite of the shortage of machine tools at that time. The leading products of agricultural plants are generally taken as a part of the national economy plan of the locality, thus ensuring supply of funds and raw materials. The government, still more, has applied appropriate price policies and fuel supply policies as well as other supports to help the plants to tide over transient difficulties and move progressively towards self-reliance. For years, the plants have trained large number of skilled workers and capable technical personnel, of them quite a few have been appointed heads of plants. All the government supports have ensured the development of agricultural machinery plants.

12. <u>The plants should be equiped, both physically and mentally, with greater flexibility and ability to meet the changing demands</u>. With the development of rural production, peasants have been diversifying their demand for machinery and equipment not only for agriculture, but also for forestry, animal-husbandry, fishery, and side-line product processing.

The progressing agricultural production technology often require new type of agricultural machines. For example, the newly developed plastic film mulching technology has been warmly and widely welcome by peasants. It is because that the yield of cotton, some vegetables and other crops can

increase by 10-30% with this method. The peasants urgently demand that the plants provide film mulching equipment in large quantities. As a result of the flexibility and quick actions taken by the plants, thousands of such equipment, of different sizes and constructions, have been turned out, thus enabling the spreading of the new technique with an unpredicated fast speed all over China. Therefore, it is necessary for a plant to have its facilities and personnel's technical competence sufficiently flexible to meet changeable environment. Also the plants should know how to manage the seasonally diversified and comparatively small-batch production. In short, the head of a plant should always keep in mind and be flexible to the changeable market demand.

13. Solid backing of basic industries is indispensable for developing multi-purpose agricultural machinery plant. Although a multi-purpose agricultural machinery plant is usually the only machine building enterprise in the locality, yet it should not be regarded as an " almighty " unit which could be operated in isolation. In fact, it almost cannot carry out any production or repair works without the support of domestic and even foreign machine building industry and basic industries. For example, all the bearings, standardized elements, service parts and belts are provided by specialized plants; some special works such as steel casting, electroplating and even iron casting are done with the cooperation of specialized plants. Specific elements such as blades, shares, chains, etc. which require special manufacturing technology are desirably produced in specialized plants in case they are in great demand. As for the provision of various raw materials, the agricultural machinery plants are still more depedent on other allied sectors. These are the factors worthwile to take into careful consideration at the stage of plant planning.

14. Unremitting renewal of product design and improvement of technical competence

A multi-purpose agricultural machinery plant must uninterruptedly develop new products, and adopt new technologies to improve the quality of their products while reducing the cost in order to achieve good economic results.

China has agricultural machinery research institutes in each and every province, municipality, and county in addition to the national institutions. These institutes develop new products and technologies, in line with local conditions, which are applicable to the multi-purpose agricultural machinery plants. Besides, the plants can also benefit from cooperation with agricultural machinery colleges and professional high schools.

Further, there are research institutes within some of the multi-purpose agricultural machinery plants. The No.3 Agricultural Machinery Plant of Zhongshan County in Guangdong, for instance, has a research institute mainly engaged in the development of tractor-boat and implements. This in-plant institute has made considerable contributions to the technology development and technical force reserve of the plant itself.

15. Standardization is of fundamental importance to technical works. As is known to all, standardization has immediate affects on all aspects of engineering including machine design, manufacturing technology, specifications for equipment and raw materials, spare parts and service, etc.

Standardization ensures desirable quality of products and interchangeability of component parts, so as to make the assembling work easy. Also, standardization is prerequisite for the direct replacement repair technology with which the worn out parts are replaced directly with new ones. To correctly carry out this simple and reliable repair technology is of great importance to both the users and the plants themselves.

Over two hundred items of the National Standard are for agricultural machinery and implements in China. In addition, the plants should have standards of their own. Some plants set their standards somewhat stricter than the National Standard with a view to ensuring the quality of products good enough to meet the requirements of the National Standard. In case there is no ready National Standard for a certain product, the plant should set an appropriate plant standard itself. In order to better develop domestic technology and to enhance cooperations with other countries, it is desirable that the National Standard approaches the International Standard progressively.

16. To apply appropriate technology to ensure best overall economic effect

We have mentioned in section 14 that the plant should make the widest possible use of new designs, and advanced technologies, equipment and materials. However, a plant should never be devorced from its own actual conditions such as scale of production, production facilities, etc. which are even more limited for an agricultural machinery plant. Therefore, to adopt the " appropriate technology " which is technically feasible and economically reasonable to agricultural machine building is considered to be a realistic practice. A few examples of " appropriate technology " are: to make component parts of high strength with nodular cast graphite iron instead of cast steel; to replace special-shaped steel with welding-shaped steel; and to adopt chill cast iron instead of soft-centre steel for plow share and mouldboard, etc.

17. Multi-purpose production needs powerful second line

A multi-purpose agricultural machinery plant must be capable of doing its work, to a certain extent, independently though it is rather dependent on other sectors as mentioned earlier. China's experience suggests that multi-purpose production needs powerful second line, namely, service shop

and tool-making shop fitted with installations making up 20% of the total plant. Workers in the second line should be of higher skill. This second line should be capable of making various technology equipment, simple special machine tools, non-standard equipment, test rigs, and whatever for emergency needs. It also, if necessary, take part in regular production.

18. Quality of product is the lifeblood of multi-purpose plant

The necessity of producing manifold products in small batches makes the price and quality difficult problems of which the quality problem remains first to be solved. Agricultural machines of poor quality will cause waste of labor and fuel, poor field operation, and even heavy losses due to failure of timely farming operation. What is more, the plant will stop production or even close down in case it is incapable of improving the quality of its products without delay. Having drawn the lessons like that, we firmly regard that the quality of agricultural machines, which possess some unique impact on the development of agriculture, is the lifeblood of the plant.

In order to guarantee high quality of products, the plant should seize the key link---quality first. For this reason, the plant ought to set up total quality control system, and equips itself with necessary check personnel and measuring instruments.

The government has stipulated that after the machines are sold out, repair, replacement and even sending back are guaranteed by the plants if the products are not up to the standard. As for price, it is affected by quite a few factors of which the management competence is the key one.

19. Appropriate repairing method and service system

Repair is one of the major jobs for the multi-purpose plant. The repair of agricultural machines should be carried out losing no time, otherwise the peasants will suffer heavy loss.

How to handle the repair jobs for numerous large- and medium-sized tractors and a variety of agricultural machines is a complicate question. We take different measures in different stages. In the past, China built a number of specialized repair plant fitted with manifold special purpose rigs for various repair works. It was fairly useful at that time. However, at present, it is most desirable to adopt direct replacement repair technology because this is a reliable and economical practice. Even then, it is still necessary for the plant to do some special repair works such as mending up the cylinder block, crankshaft grinding, etc. Therefore, the plant should produce sufficient spare parts for its own products, and in the same time have some necessary special repair rigs and measuring devices for special repair jobs.

20. Agricultural machinery plant's location should be convenient for its construction, operation and development. It would be best if a plant is located close by city or town so as to get access to energy and water resources, and better infrastructure. The plant will also benefit from more plentiful labor resource and better daily life facilities for its workers if it is located near city or town. China's agricultural machinery plants are mostly located near the county town. In addition to all the favorable factors mentioned above, a suitable site will also facilitate the cooperation with other factories and sectors.

21. Provide enough room for further development

Numerous agricultural machinery plants in China have developed on the basis of collective workshops or blacksmith's shops. It is apparent and easy to understand that the layouts of quite a few such plants are unreasonable and uneconomical owing to lack of due consideration of development at the stage of drafting. So, when working out the general layout for a multi-purpose agricultural machinery plant it is necessary to plan the buildings, piping and other facilities distinctive for " multi-purpose " and to leave reasonably

plenty room for further development. It is obvious, the multi-purpose agricultural machinery plants in developing countries are both the fundation and starting point of agricultural machinery industry. They will expand along with the development of industry of the country.

22. Give persistent attention to the training of technical personnel

Agricultural machinery plants are, usually, comparatively close to the countryside. Considerable number of workers are coming from countryside and are less skilled. Obviously, the training of workers and making them stable at the work should be taken into serious consideration as a part of the construction planning of the plant. The workers of a multi-purpose plant must have skill no less than that of the ordinary factories and must be expert in one thing and good at many. There should be one or two workers with skill in each and every type of work team as the backbone. Technical personnel had better make up 4-6 % of the total staff of the plant. They are also required to be capable of handling different jobs, to deal with designing of implements, or to deal with manufacturing technologies, as production demand. The authorities concrned have conducted many effective training courses for technical personnel, either in-service or released from work to take part in training.

23. Multi-purpose production needs sound management

As China has experienced, whether or not a multi-purpose plant well keep regular production largely depends on a sound management which is guaranteed by a whole set of effective rules and regulations involing production planning, total quality control, R & D of new product, and technology process control, etc. In fact, the management art of a multi-purpose plant, in comparasion with the specialized plant, is much more complicated due to the variable planning, market and after-sale service.

The management staff must be well trained to be qualified

to run the plant featuring " multi-purpose ". They also need to renew the management with advanced method. In this respect, the No.2 Agricultural Machinery Plant of Foshan applied value engineering principles to thresher production and achieved better economic results.

24. After-sale service---one of the key links for the development of the plant

After-sale service is the last link in the production management, and, in a sense, the starting point for further progress and thrivingness of the plant. It links the end users close to the plant. Does the product quality satisfy the users? How about the applicability of products to agriculture? In one word, all the marketing information and forcast highly depend on this link-up. Such an important matter, the after-sale service, has been often erroneously ignored in the past time in our country. As mentioned in section 9, the production of plant used to be controlled by the government planning departments which are far remote from the county plants. As a result, overstock or out of stock of agricultural machinery products were not uncommon. However, after readjusting the economy system , all plants, no matter they are small or big, start to attach great importance to after-sale service as well as market forcast.

Together with delivery of machines to the countryside, the plants should provide guidance or training for the peasants to operate and repair the machins correctly. It is also an effective measure to avert accidents.

The plants must make every effort to provide sufficient replacement parts. This is the best way for the plants to guarantee their machines working normally and to maintain a good market.

IV. Conclusion

To review the past thirty odd years, we can find that China has achieved good results and also drawn useful lessons from both construction and management of multi-purpose machinery plant. The document briefly summarizes those experiences as well as lessons for your reference. And the summarized sections, or points of importance, will serve as guidlines for elaborating the document " Design and Study of Mulci-purpose Agricultural Machinery Plants ".

It could be well anticipated that the multi-purpose agricultural machinery plant will advance, through unceasing improvement, towards an even brighter future along with the modernization of agriculture and rural industry of the country.

Some agricultural machinery plants in Foshan District of Guangdong Province

Table 1

No.	Manufacturer	Date of founding	Stuff and worker		Area (m^2)		Equipment (unit)		Current product		Total output value (million yuan)	Labor productivity (yuan/person)	Profit (ten thousand yuan)	Fixed assets (million yuan)
			Total	Technical personnel	Total	Floor area of building	Total	Metal-cutting machine tool	Item	Annual production (unit)				
1	No.3 Agricultural Machinery Plant of Zhongshan County	1958	318	4	40329	18023	160	94	tractor-boat thresher winnower bench drill	20 17141 4922 780	3.23	10,098	34.8	1.6
2	No.2 Agricultural Machinery Plant of Shunde County	1972	449	19	14200	14800	136	127	propeller oxegenater spare parts distributer type injuction pump	633 370 16,000 (pieces) 2,208	3.05		5 20 3	
3	No.3 Agricultural Machinery Plant of Sanshui County	1970	229	12	50000	9345	72	45	thresher winnower spare parts rice mill	17,000 600 for 4,000 units 300	2.17	9,300	21	1.6
4	No.2 Agricultural Machinery Plant of Foshan District	1976	398						windrower thresher walking tractor water pump	7,000 36,000	4.57	11,200	11.7	
5	Mouldboard and Share Foundry of Nanhai County	1969	230						mouldboard & share cast pot grinding ball cast railing	200 thousand pieces for each	2.3	10,000	17	
6	Tractor-drawn Implement Plant of Gwangdong	1949	1020	42	70000	37400	428		harvester thresher walking tractor	50 21,000	5.16		7.27	4.6

Products of some agricultural machinery plants
in Foshan District of Guangdong Province Table 2

No.	Manufacturer	Traditional product
1	No.3 Agricultural Machinery Plant of Zhongshan County	tractor- boat, manual thresher, silage mixer, animal-drawn plow bottom, sheet metal shear, puncher, bench drill, sickle
2	No.2 Agricultural Machinery Plant of Shunde County	river boat propeller, oxygenater, distributer type injection pump assembly, 190 cylinder block, 190 cylinder head, plastic squeezer, fan shaft, fuel injector
3	No.3 Agricultural Machinery Plant of Sanshui	manual thresher, electric-powered rice thresher, winnower, rice mill, walking tractor(4hp), dryer, spare parts, brickmaking machine
4	No.2 Agricultural Machinery Plant of Foshan District	winnower, thresher, walking tractor(4hp), mini-pump
5	Mouldboard & Share Foundry of Hainan County	Share & mouldboard, cast pot, grinding ball, cast railing
6	Tractor-drawn Implement Plant of Guangdong	harvester, disk mower, single-bottom bush plow, plow series(1 to 6 bottom), paddy field harrow, thresher, walking tractor and accessories (single bottom ploe, spike harrow, pulverizer, rotary tiller, mower, windrower, trailer, thresher, pump, sprayer, etc.), single cylinder washer(household), washer (50kg, industrial), water purifying equipment